2023

INTEGRATED SOLUTIONS: SCIENCE, ENGINEERING, & MANAGEMENT

VISHAL SAGAR
ASHWINI KR. SHARMA
REENA SAXENA

ISBN: 978-81-961781-0-9

PUBLISHED BY: ASIAN PUBLICATION CORPORATION

ADDRESS: 11/100, RAJENDRA NAGAR, SECTOR-3, SAHIBABAD-201005

Integrated Solutions: Science, Engineering, & Management

Editor: Dr. Vishal Sagar
Dr. Ashwini K. Sharma
Dr. Reena Saxena

ISBN (Print): 978-81-961781-0-9

First published in 2023.

Integrated Solutions: Science, Engineering, & Management

Edited by

Dr. Vishal Sagar

Professor & Director, Chandigarh School of Business, Jhanjeri, Mohali-140307 (Punjab), India

Dr. Ashwini K. Sharma

Professor, Department of Applied Sciences, Chandigarh Engineering College Jhanjeri, Mohali-140307 (Punjab), India

Dr. Reena Saxena

Assistant Professor, School of Applied Sciences, Suresh Gyan Vihar University, Jaipur (Rajasthan), India

INDEX

INTEGRATED SOLUTIONS: SCIENCES

CHAPTER-1.1

Inventory Model with Weibull Distribution Deterioration, Constant Demand and Shortages

Sandeep Kumar Chaudhary[1], Dr. Bharat V.P.S. Rawat[2]
[1]Associate Professor, Department of Mathematics, JB Institute of Technology, Dehradun 248197 (UK) INDIA.
E-mail:- drsandeep.chaudhary@jbitdoon.edu.in
[2]Associate Professor, Department of Mechanical Engineering, JB Institute of Technology, Dehradun, 248197 (UK) INDIA

ABSTRACT- *In this paper, we develop an order level inventory model with Weibull distribution deterioration and stock-level demand under shortages. Holding cost is taken as exponential time dependent. Mathematical model is established for finding optimal total cost. Numerical examples are presented to validate the proposed model. Sensitivity analysis is given for the validation of several key parameters. The second order approximations are used for exponential terms.*

Keywords: - Inventory, Weibull distribution, Deterioration, Time dependent, Stock-dependent.

INTRODUCTION

The deterioration of items is real problem in many industries those manufacturing goods for public use. Therefore, it is one of many crucial issues that the supply chain organizers are facing in the past decades. The main aim of inventory management to keep items fresh till these are placed on customers' hand. Most of the item's loss their masses throughout lifetime due to deteriorations, spoilage and several other causes. Thus, it is important to consider the effect of deteriorations in most of inventory systems. For example, products like fruits, green vegetables etc suffer from direct decay during shortage. Hence deteriorations are the realistic feature for inventory system. Covert and Philip (1973) discussed an inventory model for deteriorating items elaborated by the Weibull distribution and without shortage. Misra (1975) established an EOQ model with a Weibull distribution rate for the perishable items. Dave and patel (1981) considered an inventory model for deteriorating items with time induced demand. Wu (1998) presented a model for deteriorating item under permissible decay in payments and shortages. Elsayed and Teresi (1983) worked on time varying demand and shortages induced inventory model. Taleizadeh. et al (2015) developed a vendor managed inventory model for a two-level supply chain comprised of one vendor and several non-competing retailers in which both the raw material and the finished products have different deteriorations rate. Chen and Lui (2002) pointed out a dynamic programming model for solving a deteriorating inventory replenishment problem with continuous time varying demand under inflationary conditions. Sana et al (2004) derived an EOQ model for deteriorating items in which the optimal number of production cycle is a linear time-varying demand. Lin et al (2010) established an EOQ model for deteriorating items for a two layers supply chains. Lodree and Uzochukwn (2008) studied deteriorating inventory modelin which the demand for fresh items are random variable with known probability distributions. Ghiami and Williams (2015) considered a single manufacturer multi-buyer model for a deteriorating item with finite production rate. Several concern research papers to deteriorating products can

be found in Bakker et al (2012), Atici et al (2013), Dye et al (2007), goyal and Giri (2003), Chang et al (2010), Yang et al (2010), Sarkar et al (2013), Tripathi et al (2016), Tripathi (2012, 2014).

It is observed that the proper amount of stock is a major concern for research. The first research article published by Leveis et al (1972) for stock dependent demand. Goyal and Chang (2009) delt with an ordering transfer inventory model to determine the retailer's optimal order quantity and the number of transfers per order from the warehouse to the display area. Baker and Urban (1988) considered an inventory model for a power form. Stock dependent demand pattern. Ray and Chaudhari (1997) established a model with inventory induced demand and shortages. Jiangtao, et al (2014) presented a multi-items inventory model for perishable items when the demand rates of the items are stock-dependent, two level trade credit is adopted and the restriction of inventory capacity is also considered. Soni (2013) presented an EOQ model considered (i) the demand rate as multivariate functions of price and level of inventory & (ii) delay in payments are permissible. Min et al (2010) considered a lot-sizing model for deteriorating items with current-stock dependent demand delay in payments. There are some interesting research papers on stock dependent such as Teng et al (2011), Yang (2014), Hwang and Hahn (2000), Ray (2008), Pando et al (2012), Tripathi (2013), Shukla et al (2015), Tripathi and uniyal (2014) and references therein.

The aim of this work is to obtain minimum total cost with respect to cycle time. The remaining part of the work is as given below: Notation and assumptions are discussed in section 2 followed by mathematical model. Numerical examples are illustrated in section 4 followed by sensitivity analysis. Conclusion and future research are provided in section 6.

ASSUMPTION & NOTATIONS

The following notations are adopted in the

Notations

I(t) : Positive inventory level at time t.

t_1 : The time at which the inventory level reaches to zero

T : The time at which shortage accure.

C_4 : Per order constant ordering cost.

s : Shortage cost per unit & per unit time.

C_3 : Unit cost of an item.

A : Shortage during $t_1 < t < T$.

Q_1 : Maximum positive inventory

R : Maximum Negative inventory

P : Order quantity during [0, T]

We adopted following assumptions.

Assumptions

- The lead time is taken as zero.
- h is holding cost/unit
- $D\{I_1(t)\} = \gamma + \delta I_1(t)$
- $\theta(t) = \alpha \beta t^{\beta-1}$: the two parameter Weibull distribution deterioration rate. Where $0 \leq \alpha << 1$ is the scale parameter; $\beta > 0$ is the shape parameter.
- Shortages are allowed.

INVENTORY LEVEL

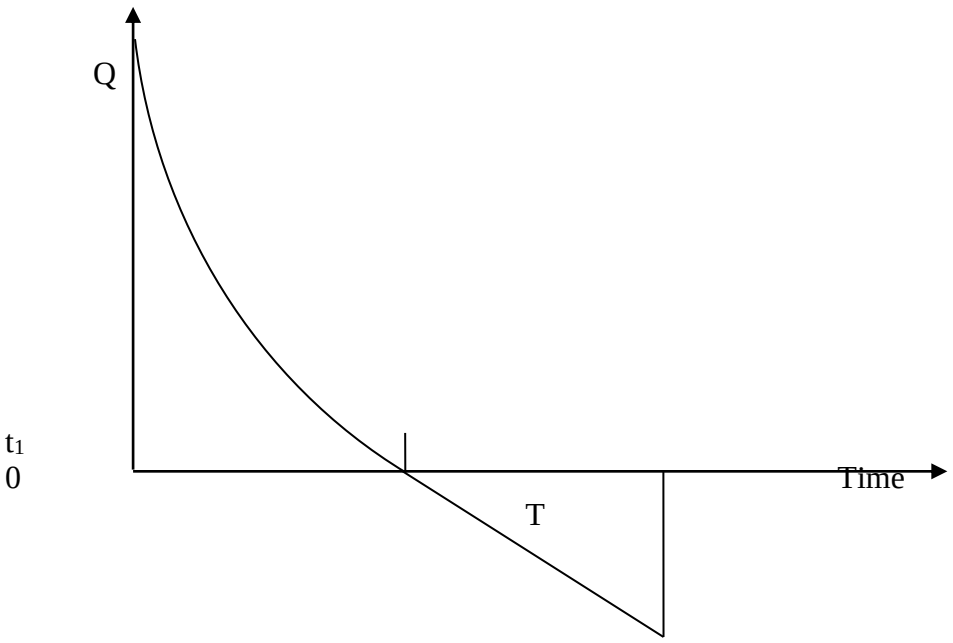


fig.−1 Grapgical representation of inventory system

MATHEMATICAL MODEL

Now the rate of change of inventory depends on deterioration and demand. The differential equations of the state at time [0, T] are given by:

$0 < t < t_1$ $$\frac{dI_1(t)}{dt} + \theta(t).I_1(t) = -D\{I_1(t)\} \quad (1)$$

We use initial and boundary condition as $I_1(t_1) = I_2(t_1) = 0$ and $I_1(0) = Q_1$. (2)

And $$\frac{dI_2(t)}{dt} = -A \qquad t_1 < t < T \quad (3)$$

The solution of eqns.(1)& (3) are given by

$$I_1(t) = \gamma . e^{-\alpha t^{\beta}} . e^{-\delta t} \left[\left\{ t_1 + \frac{\delta t_1^{\,2}}{2} + \frac{\delta^2 t_1^{\,3}}{6} + \frac{\alpha t_1^{\,\beta+1}}{(\beta+1)} + \frac{\alpha.\delta.t_1^{\,\beta+2}}{(\beta+2)} + \frac{\alpha.\delta^2.t_1^{\,\beta+3}}{2(\beta+3)} \right\} - \left\{ t + \frac{\delta t^2}{2} + \frac{\delta^2 t^3}{6} + \frac{\alpha t^{\beta+1}}{(\beta+1)} + \frac{\alpha.\delta.t^{\beta+2}}{(\beta+2)} + \frac{\alpha.\delta^2.t^{\beta+3}}{2(\beta+3)} \right\} \right] \quad (4)$$

$$I_2(t) = -A\,(t - t_1) \quad (5)$$

Now maximum positive inventory is

$$Q_1 = \gamma . \left[\left\{ t_1 + \frac{\delta t_1^{\,2}}{2} + \frac{\delta^2 t_1^{\,3}}{6} + \frac{\alpha\, t_1^{\,\beta+1}}{(\beta+1)} + \frac{\alpha.\delta.t_1^{\,\beta+2}}{(\beta+2)} + \frac{\alpha.\delta^2.t_1^{\,\beta+3}}{2(\beta+3)} \right\} \right] \tag{6}$$

Now the holding cost

$$h(t) = \int_0^{t_1} h.\ I_1(t)\, dt \tag{7}$$

$$= \gamma . h \left[\left(t_1 - \frac{\delta t_1^{\,2}}{2} - \frac{\alpha\, t_1^{\,\beta+1}}{(\beta+1)} + \frac{\alpha.\delta.t_1^{\,\beta+2}}{(\beta+2)} + \frac{\delta^2 t_1^{\,3}}{6} - \frac{\alpha.\delta^2.t_1^{\,\beta+3}}{2(\beta+3)} \right) . \left(t_1 + \frac{\delta t_1^{\,2}}{2} + \frac{\delta^2 t_1^{\,3}}{6} \right.\right.$$

$$\left. + \frac{\alpha\, t_1^{\,\beta+1}}{(\beta+1)} + \frac{\alpha.\delta.t_1^{\,\beta+2}}{(\beta+2)} + \frac{\alpha.\delta^2.t_1^{\,\beta+3}}{2(\beta+3)} \right) - \left\{ \frac{t_1^{\,2}}{2} + \frac{\delta.t_1^{\,3}}{6} + \frac{\delta^2.t_1^{\,4}}{24} + \frac{\alpha.t_1^{\,(\beta+2)}}{(\beta+1).(\beta+2)} + \right.$$

$$\frac{\alpha.\delta.t_1^{\,(\beta+3)}}{(\beta+2).(\beta+3)} + \frac{\alpha.\delta^2.t_1^{\,(\beta+4)}}{2.(\beta+2).(\beta+4)} - \frac{\delta.t_1^{\,3}}{3} - \frac{\delta^2.t_1^{\,4}}{8} - \frac{\delta^3.t_1^{\,5}}{30} - \frac{\alpha.\delta.t_1^{\,(\beta+3)}}{(\beta+1).(\beta+3)}$$

$$- \frac{\alpha.\delta^2.t_1^{\,(\beta+4)}}{(\beta+2).(\beta+4)} - \frac{\alpha.\delta^3.t_1^{\,(\beta+5)}}{2.(\beta+3).(\beta+5)} - \frac{\alpha.\, t_1^{\,(\beta+2)}}{(\beta+2)} - \frac{\alpha.\delta.t_1^{\,(\beta+3)}}{2.(\beta+3)} - \frac{\alpha.\delta^2.t_1^{\,(\beta+4)}}{6.(\beta+4)} -$$

$$\frac{\alpha^2.t_1^{\,(2\beta+2)}}{(\beta+1).(2\beta+2)} - \frac{\alpha^2.\delta.t_1^{\,(2\beta+3)}}{(\beta+2).(2\beta+3)} - \frac{\alpha^2.\delta^2.t_1^{\,(2\beta+4)}}{2.(\beta+3).(2\beta+4)} + \frac{\alpha.\delta.t_1^{\,(\beta+3)}}{(\beta+3)} +$$

$$\frac{\alpha.\delta^2.t_1^{\,(\beta+4)}}{2.(\beta+4)} + \frac{\alpha.\delta^3.t_1^{\,(\beta+5)}}{6.(\beta+5)} + \frac{\alpha^2.\delta.t_1^{\,(2\beta+3)}}{(\beta+1).(2\beta+3)} + \frac{\alpha^2.\delta^2.t_1^{\,(2\beta+4)}}{(\beta+2).(2\beta+4)} + \frac{\alpha^2.\delta^3.t_1^{\,(2\beta+5)}}{2.(\beta+3).(2\beta+5)}$$

$$+ \frac{\delta^2.t_1^{\,4}}{8} + \frac{\delta^3.t_1^{\,5}}{20} + \frac{\delta^4.t_1^{\,6}}{72} + \frac{\alpha.\delta^2.t_1^{\,(\beta+4)}}{2.(\beta+1).(\beta+4)} + \frac{\alpha.\delta^3.t_1^{\,(\beta+5)}}{2.(\beta+2).(2\beta+5)} + \frac{\alpha.\delta^4.t_1^{\,(\beta+6)}}{4.(\beta+3).(\beta+6)}$$

$$- \frac{\alpha.\delta^2.t_1^{\,(\beta+4)}}{2.(\beta+4)} - \frac{\alpha.\delta^3.t_1^{\,(\beta+5)}}{4.(\beta+5)} - \frac{\alpha.\delta^4.t_1^{\,(\beta+6)}}{12.(\beta+3)} - \frac{\alpha^2.\delta^2.t_1^{\,(2\beta+4)}}{2.(\beta+1).(2\beta+4)} - \frac{\alpha^2.\delta^3.t_1^{\,(2\beta+5)}}{2.(\beta+2).(2\beta+5)}$$

$$\left. - \frac{\alpha^2.\delta^4.t_1^{\,(2\beta+6)}}{4.(\beta+3).(2\beta+6)} \right\} \Bigg] \tag{8}$$

The maximum backorder unit:-

$$Q_2 = -\, I_2(T) = A\,(T - t_1) \tag{9}$$

Hence the order size during [0, T]

$$M(t) = Q_1 + Q_2$$

$$= \gamma . \left[\left\{ t_1 + \frac{\delta t_1^{\,2}}{2} + \frac{\delta^2 t_1^{\,3}}{6} + \frac{\alpha\, t_1^{\,\beta+1}}{(\beta+1)} + \frac{\alpha.\delta.t_1^{\,\beta+2}}{(\beta+2)} + \frac{\alpha.\delta^2.t_1^{\,\beta+3}}{2(\beta+3)} \right\} \right] + A(T - t_1) \tag{10}$$

The total shortage cost during interval [t_1 , T] is :-

$$SC = -s \int_{t_1}^{T} I_2(t)\, dt \tag{11}$$

$$= \frac{A.s}{2} \left[T - t_1 \right]^2 \tag{12}$$

Now the purchase cost is as follows:-

$$PC = C_3 .M(t) \tag{13}$$

$$= C_3\left[\gamma .\left\{t_1 + \frac{\delta t_1^{\,2}}{2} + \frac{\delta^2 t_1^{\,3}}{6} + \frac{\alpha\, t_1^{\,\beta+1}}{(\beta+1)} + \frac{\alpha.\delta.t_1^{\,\beta+2}}{(\beta+2)} + \frac{\alpha.\delta^2.t_1^{\,\beta+3}}{2(\beta+3)}\right\} + A(T-t_1)\right] \quad (14)$$

Ordering cost is taken as constant

$OC = C_4$

The total average cost is as follows:-

$$Z = \frac{1}{T}(OC + HC + SC + PC) \quad (15)$$

$$= \frac{1}{T}\left[C_4 + \gamma.h\left[\left(t_1 - \frac{\delta t_1^{\,2}}{2} - \frac{\alpha\, t_1^{\,\beta+1}}{(\beta+1)} + \frac{\alpha.\delta.t_1^{\,\beta+2}}{(\beta+2)} + \frac{\delta^2 t_1^{\,3}}{6} - \frac{\alpha.\delta^2.t_1^{\,\beta+3}}{2(\beta+3)}\right).\left(t_1 + \frac{\delta t_1^{\,2}}{2} + \frac{\delta^2 t_1^{\,3}}{6}\right.\right.\right.$$

$$\left.\left.\left. + \frac{\alpha\, t_1^{\,\beta+1}}{(\beta+1)} + \frac{\alpha.\delta.t_1^{\,\beta+2}}{(\beta+2)} + \frac{\alpha.\delta^2.t_1^{\,\beta+3}}{2(\beta+3)}\right) - \left\{\frac{t_1^2}{2} + \frac{\delta.t_1^{\,3}}{6} + \frac{\delta^2.t_1^{\,4}}{24} + \frac{\alpha.t_1^{(\beta+2)}}{(\beta+1).(\beta+2)} + \frac{\alpha.\delta.t_1^{(\beta+3)}}{(\beta+2).(\beta+3)}\right.\right.$$

$$\left.\left. + \frac{\alpha.\delta^2.t_1^{(\beta+4)}}{2.(\beta+2).(\beta+4)} - \frac{\delta.t_1^{\,3}}{3} - \frac{\delta^2.t_1^{\,4}}{8} - \frac{\delta^3.t_1^{\,5}}{30} - \frac{\alpha.\delta.t_1^{(\beta+3)}}{(\beta+1).(\beta+3)} - \frac{\alpha.\delta^2.t_1^{(\beta+4)}}{(\beta+2).(\beta+4)} - \frac{\alpha.\delta^3.t_1^{(\beta+5)}}{2.(\beta+3).(\beta+5)}\right.$$

$$= \frac{1}{T}\left[\gamma.h\left[\left\{2t_1 + \frac{3.\delta.t_1^{\,2}}{2} + \frac{2.\delta^2.t_1^{\,3}}{3} + \frac{\alpha.(\beta+2).t_1^{(\beta+1)}}{(\beta+1)} + \frac{\alpha.\delta.(\beta+3).t_1^{(\beta+2)}}{(\beta+2)} + \frac{\alpha.\delta^2.(\beta+4).t_1^{(\beta+3)}}{2.(\beta+3)}\right.\right.\right.$$

$$\left.\left.\left. - \frac{3.\delta.t_1^{\,2}}{2} - \delta^2.t_1^{\,3} - \frac{5.\delta^3.t_1^{\,4}}{12} - \frac{\alpha.\delta.(\beta+3).t_1^{(\beta+2)}}{2.(\beta+1)} - \frac{\alpha.\delta^2.(\beta+4).t_1^{(\beta+3)}}{2.(\beta+2)} - \frac{\alpha.\delta^3.(\beta+5).t_1^{(\beta+4)}}{4.(\beta+3)}\right.\right.\right.$$

$$\left.\left.\left. - \frac{\alpha.(\beta+2).t_1^{(\beta+1)}}{(\beta+1)} - \frac{\alpha.\delta.(\beta+3).t_1^{(\beta+2)}}{2.(\beta+1)} - \frac{\alpha.\delta^2.(\beta+4).t_1^{(\beta+3)}}{6.(\beta+1)} - \frac{\alpha^2.(2\beta+2).t_1^{(2\beta+1)}}{(\beta+1)^2} - \right.\right.\right.$$

$$\left.\left.\left. \frac{\alpha^2.\delta.(2\beta+3).t_1^{(2\beta+2)}}{(\beta+1)(\beta+2)} - \frac{\alpha^2.\delta^2.(2\beta+4).t_1^{(2\beta+3)}}{2.(\beta+1)(\beta+3)} + \frac{\alpha.\delta.(\beta+3).t_1^{(\beta+2)}}{(\beta+2)} + \frac{\alpha.\delta^2.(\beta+4).t_1^{(\beta+3)}}{2.(\beta+2)}\right.\right.\right.$$

$$\left.\left.\left. + \frac{\alpha.\delta^3.(\beta+5).t_1^{(\beta+4)}}{6.(\beta+2)} + \frac{\alpha^2.\delta.(2\beta+3).t_1^{(2\beta+2)}}{(\beta+1).(\beta+2)} + \frac{\alpha^2.\delta^2.(2\beta+4).t_1^{(2\beta+3)}}{(\beta+2)^2} + \frac{\alpha^2.\delta^3.(2\beta+5).t_1^{(2\beta+4)}}{2.(\beta+2).(\beta+3)}\right.\right.\right.$$

$$\left.\left.\left. + \frac{3.\delta^2.t_1^{\,3}}{3} + \frac{3.\delta^3.t_1^{\,4}}{12} + \frac{\delta^4.t_1^{\,5}}{6} + \frac{\alpha.\delta^2.(\beta+4).t_1^{(\beta+3)}}{6.(\beta+1)} + \frac{\alpha.\delta^3.(\beta+5).t_1^{(\beta+4)}}{6.(\beta+2)} + \frac{\alpha.\delta^4.(\beta+6).t_1^{(\beta+5)}}{12.(\beta+3)}\right.\right.\right. \quad (16)$$

Now to minimize the total cost Z per unit time, we obtain the optimum value of t_1 and T with help of following equations $\frac{\partial Z}{\partial t_1} = 0$ *and* $\frac{\partial Z}{\partial T} = 0.$

Now $\frac{\partial Z}{\partial t_1} = 0$

$$-\frac{\alpha.t_1^{(\beta+2)}}{(\beta+2)} - \frac{\alpha.\delta.t_1^{(\beta+3)}}{2.(\beta+3)} - \frac{\alpha.\delta^2.t_1^{(\beta+4)}}{6.(\beta+4)} - \frac{\alpha^2.t_1^{(2\beta+2)}}{(\beta+1).(2\beta+2)} - \frac{\alpha^2.\delta.t_1^{(2\beta+3)}}{(\beta+2).(2\beta+3)} - \frac{\alpha^2.\delta^2.t_1^{(2\beta+4)}}{2.(\beta+3).(2\beta+4)}$$

$$+ \frac{\alpha.\delta.t_1^{(\beta+3)}}{(\beta+3)} + \frac{\alpha.\delta^2.t_1^{(\beta+4)}}{2.(\beta+4)} + \frac{\alpha.\delta^3.t_1^{(\beta+5)}}{6.(\beta+5)} + \frac{\alpha^2.\delta.t_1^{(2\beta+3)}}{(\beta+1).(2\beta+3)} + \frac{\alpha^2.\delta^2.t_1^{(2\beta+4)}}{(\beta+2).(2\beta+4)} + \frac{\alpha^2.\delta^3.t_1^{(2\beta+5)}}{2.(\beta+3).(2\beta+5)}$$

$$+ \frac{\delta^2.t_1^{\,4}}{8} + \frac{\delta^3.t_1^{\,5}}{20} + \frac{\delta^4.t_1^{\,6}}{72} + \frac{\alpha.\delta^2.t_1^{(\beta+4)}}{2.(\beta+1).(\beta+4)} + \frac{\alpha.\delta^3.t_1^{(\beta+5)}}{2.(\beta+2).(2\beta+5)} + \frac{\alpha.\delta^4.t_1^{(\beta+6)}}{4.(\beta+3).(\beta+6)} - \frac{\alpha.\delta^2.t_1^{(\beta+4)}}{2.(\beta+4)}$$

$$\left.\left. - \frac{\alpha.\delta^3.t_1^{(\beta+5)}}{4.(\beta+5)} - \frac{\alpha.\delta^4.t_1^{(\beta+6)}}{12.(\beta+3)} - \frac{\alpha^2.\delta^2.t_1^{(2\beta+4)}}{2.(\beta+1).(2\beta+4)} - \frac{\alpha^2.\delta^3.t_1^{(2\beta+5)}}{2.(\beta+2).(2\beta+5)} - \frac{\alpha^2.\delta^4.t_1^{(2\beta+6)}}{4.(\beta+3).(2\beta+6)}\right\}\right]$$

$$+ \frac{A.s}{2}\left[T - t_1\right]^2 + C_3\left[\gamma .\left\{t_1 + \frac{\delta t_1^{\,2}}{2} + \frac{\delta^2 t_1^{\,3}}{6} + \frac{\alpha\, t_1^{\,\beta+1}}{(\beta+1)} + \frac{\alpha.\delta.t_1^{\,\beta+2}}{(\beta+2)} + \frac{\alpha.\delta^2.t_1^{\,\beta+3}}{2(\beta+3)}\right\} + A(T-t_1)\right]\Bigg]$$

$$-\frac{\alpha.\delta^2.(\beta+4).t_1^{(\beta+3)}}{2.(\beta+3)}-\frac{\alpha.\delta^3.(\beta+5).t_1^{(\beta+4)}}{4.(\beta+3)}-\frac{\alpha.\delta^4.(\beta+6).t_1^{(\beta+5)}}{12.(\beta+3)}-\frac{\alpha^2.\delta^2.(2\beta+4).t_1^{(2\beta+3)}}{2.(\beta+3).(\beta+1)}-$$

$$\frac{\alpha^2.\delta^3.(2\beta+5).t_1^{(2\beta+4)}}{2.(\beta+3)(\beta+2)}-\frac{\alpha^2.\delta^4.(2\beta+6).t_1^{(2\beta+5)}}{4.(\beta+3)^2}\Bigg\}-\Bigg\{t_1+\frac{\delta.t_1^2}{2}+\frac{\delta^2.t_1^3}{6}+\frac{\alpha.t_1^{(\beta+1)}}{(\beta+1)}+\frac{\alpha.\delta.t_1^{(\beta+2)}}{(\beta+2)}$$

$$+\frac{\alpha.\delta^2.t_1^{(\beta+3)}}{2.(\beta+2)}-\delta.t_1-\frac{\delta^2.t_1^3}{2}-\frac{\delta^3.t_1^4}{6}-\frac{\alpha.\delta.t_1^{(\beta+2)}}{(\beta+1)}-\frac{\alpha.\delta^2.t_1^{(\beta+3)}}{(\beta+2)}-\frac{\alpha.\delta^3.t_1^{(\beta+4)}}{2.(\beta+3)}-\alpha.t_1^{(\beta+1)}-$$

$$\frac{\alpha.\delta.t_1^{(\beta+2)}}{2}-\frac{\alpha.\delta^2.t_1^{(\beta+3)}}{6}-\frac{\alpha^2.t_1^{(2\beta+1)}}{(\beta+1)}-\frac{\alpha^2.\delta.t_1^{(2\beta+2)}}{(\beta+2)}-\frac{\alpha^2.\delta^2.t_1^{(2\beta+3)}}{2.(\beta+3)}+\alpha.\delta.t_1^{(\beta+2)}+\frac{\alpha.\delta^2.t_1^{(\beta+3)}}{2}$$

$$+\frac{\alpha.\delta^3.t_1^{(\beta+4)}}{6}+\frac{\alpha^2.\delta.t_1^{(2\beta+2)}}{(\beta+1)}+\frac{\alpha^2.\delta^2.t_1^{(2\beta+3)}}{(\beta+2)}+\frac{\alpha^2.\delta^3.t_1^{(2\beta+4)}}{2.(\beta+3)}+\frac{\delta^2.t_1^3}{2}+\frac{\delta^3.t_1^4}{4}+\frac{\delta^4.t_1^5}{12}+$$

$$\frac{\alpha.\delta^2.t_1^{(\beta+3)}}{2.(\beta+1)}+\frac{\alpha.\delta^3.t_1^{(\beta+4)}}{2.(\beta+2)}+\frac{\alpha.\delta^4.t_1^{(\beta+5)}}{4.(\beta+3)}-\frac{\alpha.\delta^2.t_1^{(\beta+3)}}{2}-\frac{\alpha.\delta^3.t_1^{(\beta+4)}}{4}-\frac{\alpha.\delta^4.t_1^{(\beta+5)}}{12}-$$

$$\frac{\alpha^2.\delta^2.t_1^{(2\beta+3)}}{2.(\beta+1)}-\frac{\alpha^2.\delta^3.t_1^{(2\beta+4)}}{2.(\beta+2)}-\frac{\alpha^2.\delta^4.t_1^{(2\beta+5)}}{4.(\beta+3)}\Bigg\}\Bigg]-A.s(T-t_1)+C_3\{\gamma.(1+\delta.t_1+\alpha.t_1^{\beta}+$$

$$\alpha.\delta.t_1^{(\beta+1)}+\frac{\delta^2.t_1^2}{2}+\frac{\alpha.\delta^2.t_1^{(\beta+2)}}{2})-A\}\Bigg] \tag{17}$$

As $\frac{\partial Z}{\partial T}=0.$

$$=\frac{1}{T}\left[A.s.(T-t_1)+C_3.A\right]-\frac{1}{T^2}(OC+HC+SC+PC). \tag{18}$$

It is difficult to find second order derivative for sufficient condition of optimality. We can show it by fig.-2.

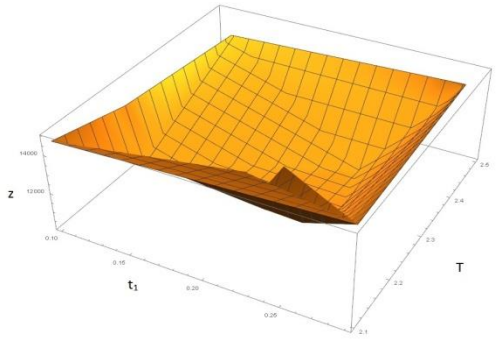


fig.-02 Z *vs.* t_1 *and* T

Above figure is convex, which proves that the optimal total cost with respect to time t_1 and T is minimum. That is, second derivative of $\frac{d^2Z}{dt_1^2}$ *and* $\frac{d^2Z}{dT^2}$ are positive.

NUMERICAL EXAMPLES

The model which is proposed by us is illustrated below by given following example:-

For the analysis of graphical and numerical solution of the developed model, value of parameters is taken as proper units, When $\alpha = 0.7$, $\beta = 4$, $\gamma = 550$, $\delta = 0.7$, $h = 10$, $s = 50$,

$A = 300$, $C_4 = 150$, $C_3 = 10$. After putting these value we get optimal solution as $t_1 = t_1^* = 1.14597$and $T = T^* = 3.35888$, $Q = Q^* = 1136.99$ and $Z = Z^* = 18000.1$.

SENSITIVITY ANALYSIS

Variation of γ keeping all parameters same as numerical example

γ	t_1	T	Q	Z
600	1.31445	3.48762	1589.36	19055.7
650	1.26526	3.39175	1438.03	18383.4
700	1.21625	3.29995	1304.02	17778.3
750	1.16734	3.21215	1184.92	17240.9
800	1.11857	3.12831	1078.0	16767.7

Variation of δ keeping all parameters same as numerical example

δ	t_1	T	Q	Z
0.9	1.12067	3.31548	1083.21	17770.4
1.1	1.10603	3.28425	1053.47	17608.8
1.3	1.10093	3.26365	1043.34	17499.7
1.5	1.10568	3.25346	1052.77	17440.2
1.7	1.12223	3.25479	1086.44	17440.1

Variation of β keeping all parameters same as numerical example

β	t_1	T	Q	Z
4.5	1.33421	3.57342	1655.4	19563.9
5.0	1.30882	3.56109	1571.11	19383.4
5.5	1.28694	3.55037	1502.52	19243.5
6.0	1.2679	3.54099	1445.7	19133.4
6.5	1.2512	3.5327	1397.0	19045.4

Variation of A keeping all parameters same as numerical example

A	t_1	T	Q	Z
400	1.29377	3.62042	1523.54	19619.3
500	1.4142	3.81525	1957.67	21186.0
600	1.52762	3.97464	2500.81	22854.1

700	1.67438	4.81806	3463.71	24160.6
800	1.71423	4.83803	3788.11	28443.9

Variation of s keeping all parameters same as numerical example

s	t_1	T	Q	Z
60	1.22004	3.43368	1313.83	18466.2
70	1.2937	3.5568	1523.33	19300.6
80	1.35979	3.6613	1745.74	20120.9
90	1.42143	3.75283	1988.01	20950.2
100	1.4875	3.86803	2291.39	22012.0

Variation of α keeping all parameters same as numerical example

α	t_1	T	Q	Z
0.2	1.36397	3.58776	1761.05	19801.3
0.3	1.29324	3.51517	1521.9	19093.5
0.4	1.24313	3.46267	1375.57	18666.7
0.5	1.20434	3.4215	1271.47	18376.0
0.6	1.17269	3.38763	1197.99	18163.3

Variation of C_4 keeping all parameters same as numerical example

C_4	t_1	T	Q	Z
200	1.14554	3.35613	1136.05	17985.1
250	1.14512	3.35337	1135.14	17970.2
300	1.14469	3.35061	1134.2	17955.2
350	1.14427	3.34784	1133.28	17940.3
400	1.14384	3.34507	1132.34	17925.3

Variation of C_3 keeping all parameters same as numerical example

C_3	t_1	T	Q	Z
20	0.937478	2.99644	771.042	16365.4
30	0.778539	2.72336	576.901	15478.6
40	0.63704	2.50709	441.05	15015.2
50	0.510366	2.33878	334.308	14901.1
60	0.394612	2.21371	247.919	14074.2

Variation of h keeping all parameters same as numerical example

h	t_1	T	Q	Z
2	1.32807	3.65265	1634.54	19917.5
3	1.30216	3.60965	1549.85	19596.0
4	1.27713	3.56869	1472.92	19302.3
5	1.25304	3.52964	1403.13	19043.3
6	1.22988	3.49239	1339.0	18789.6

All the above observation can be summed up as follows.

i) If γ increases, Q slightly decrease while Z slightly decrease.

ii) The increments of δ will cause decrease in Q and Z.

iii) The increase of A results, increases in Q and Z.

iv) The increases in s, will lead increases in Q and Z.

v)The increase in α will cause decrease in Q and Z.

vi) The increase in C_3 causes decrease in Q and Z.

vii) The increase in holding cost results decrease in Q & Z.

viii) The decrease in C_4 leads decrease in Q and Z.

CONCLUSION

In real life most of the future planning's are uncertain. Uncertainty plays an important role in business. In this paper we developed an inventory model for Weibull distribution deterioration and inventory dependent and inventory dependent demand. Holding cost is considered as exponential function of time. Mathematical model have been presented to find optimal inventory systems. The first and second order approximations have been used for exponential terms. The following inferences can be made for the sensitivity analysis.

(i) The increase of α & β results insignificant change in Q and Z.

(ii) The increase of s& h will cause apposite change in Q & Z.

(iii) The change in C_3 leads positive change in Q and Z.

The model discussed in the research work may be generalize considering demand as quadratic function of time. We may also extend the model for considering shortages and freight changes.

REFERENCES

[1]Atici, F.M., Lobenisky, A. and Uysal, P. (2013). Inventory model for deteriorating items on non-periodic discrete time domains. European Journal of Operational Research, 230, 284-289.

[2]Bakker, M. Reizebos,J. and Tenuter, R.H. (2012). Review of inventory systems with deterioration since, 2001.European Journal of Operational Research. 221(2), 275-284.

[3] Baker and Urban, T.L. (1988). A deterministic inventory system with an inventory level dependent demand rate. Journal of the Operational Research Society, 39, 823-831.
[4] Chang, C.T., Teng, T.T and Chern, M.S. (2010). Optimal manufacturer's replenishment policies for deteriorating items is a supply chain with upstream and downstream trade credits. International Journal of Production Economics, 127, 197-201.
[5] Chen, J.M. and Lui, C.S. (2002). An optimal replenishment model for inventory items with normally distributed deterioration. Production, Planning and Control, 13 (5), 470-480.
[6] Covert, R.P. and Philip, G.C. (1973). An EOQ model for item with Weibull distribution deterioration. AIIE Transaction, 5, 323-326.
[7] Dave, U. and Patel, L.K. (1981). (T, S_i) Policy inventory model for deteriorating items with time proportion demand. Journal of the Operational Research Society, 32, 137-142.
[8] Dye, C.Y., Hsieh, T.P. and Onyang, L.Y. (2007). Determining optimal selling price and lot size with a varying rate of deteriorating and exponential partial backlogging. European Journal of Operation Research, 181, 668-678.
[9] Elsayed, E.A. and Teresi, C. (1983). Analysis of inventory systems with deteriorating items. International Journal of Production Research, 21, 449-460.
[10] Ghiami, Y. and Williams, T. (2015). A two-echelon production-inventory model for deteriorating items with multiple buyers. International Journal of Production Economics, 159, 233-240.
[11] Goyal, S.K. and Chang, C.T. (2009). Optimal ordering and transfer policy for an inventory with stock-dependent demand. European Journal of Operation Research, 196, 177-185.
[12] Goyal, S.K. and Giri, B.C. (2003). The production inventory problem of a product with time- varying demand, production and deterioration rates. European Journal of Operation Research, 147, 549-557.
[13] Hwang, H. and Hahn, K.H. (2000). An optimal procurement policy for items with inventory level dependent demand rate and fixed lifetime. European Journal of Operation Research, 127(3), 537-545.
Jaingtao, M., Guimei, C., Teng,F. and Hong, M. (2014). Optimal ordering policies for perishable multi-items under stock-dependent demand and two-level trade credit. Applied Mathematical Modelling, 39(9-10), 2522-2532.
[14] Leveis, R.I., McLanghlins, C.P., Lamone, R.P. and Kottas, J.F. (1972). Prodeuctions Operations Management: Contemporary policy for managing operating systems. McGraw-Hill, New-York, p.373.
[15] Lodree, J.E.J. and Uzochukwu, B.M. (2008). Production planning for a deteriorating item with stochastic demand and customer choice. International Journal of Production Economics, 116(2), 219-232.
[16] Lin, Y.H., Lin, C. And Lin, B. (2010). On conflict and cooperation is a two echelon inventory model for deteriorating items. Computer and Industrial Engineering , 59(4), 703-711.
[17] Mishra, R.B. (1975). Optimum production lot size model for a system with deteriorating inventory. International Journal of Production Research, 13, 495-505.
[18] Min, J., Zhou, Y.W. and Zhao, J. (2010). An inventory model for deteriorating items under stock-dependent demand and two-level trade credit. Applied Mathematical Modelling, 34, 3273- 3285.
[19] Pando, V., Garda-Lagunaa, J., San-Jose, L.A., and Sicilia, J. (2012). Maximizing profits in an inventory model with both demand ratio and holding cost per unit time dependent on the stock level. Computers and Industrial Engineering , 62(2), 599-608.
[20] Roy, A. (2008). An inventory model for deteriorating items price dependent demand and time varying holding cost. Advanced modelling and optimization, 10(1), 25-37.
[21] Ray, J., and Chaudhari, K.S. (1997). An EOQ model with stock-dependent demand, shortage, inflation and time discounting. International Journal of Production Economics, 53, 171-180.
[22] Sana, S.S., Goyal, S.K. and Chaudhari, K.S. (2004). A production inventory model for a deteriorating items with trended demand and shortages, European Journal of Operational Research, 157(2), 357-371.
[23] Sarkar, B., Saren, S. and Wee, H.M. (2013). An inventory model with variable demand component cost and selling price for deteriorating items. Economics Modelling, 30, 306-310.
[24] Shukla, H.S., Tripathi, R.P., Siddiqui, A. and Shukla, V. (2015). EOQ model with inventory level dependent demand rate under permissible delay in payments with cash discount. Indian Journals of Science and Technology, 8(28), 1-9.
[25] Soni, H.N. (2013). Optimal replenishment policies for non- instantaneousdeteriorating items with price and stock sensitive demand under permissible delay in payment. International Journal of Production Economics, 146, 259-268.

[26] Taleizadeh, A.A., Daryan,M.N. and Barron, L.E.C. (2015). Joint optimization of price, replenishment frequency, replenishment cycle and production rate in vendor managed inventory system with deteriorating items. International Journal of Production Economics, 159, 285-299.
[27] Teng, J.T., Krommyda, I.P., Skouri,K. and Lou, K.R. (2011). A comprehensive extension of optimal ordering policy for stock-dependent demand under progressive payment scheme. European Journal of Operational Research, 215, 97-104.
[28] Tripathi, R.P. (2012). EOQ model for deteriorating items under linear time dependent demand rate under permissible delay in payments. International Journal of Operations Research, 9(1), 1-11.
[29] Tripathi, R.P.(2014). Economic Order Quantity (EOQ) for deteriorating items with non-instantaneous receipt under trade credit. International Journal of Operations Research, 12(2), 47-56.
[30] Tripathi, R.P.(2013). Inventory model with different demand rate and different holding cost. International Journal of Industrial Engineering and Computation, 4(3), 437- 446.
[31] Tripathi, R.P., Pareek,S. and Kaur,M. (2016). Inventory model with exponential time-dependent demand rate, variable deterioration, shortages and production cost. International Journal of Computational Mathematics, D 01 10.1007/s 40819-016-0185-4.
[32] Tripathi, R.P. and Uniyal.A. (2014). EOQ model with cash flow oriented and quantity dependent under trade-credits. International Journal of Engineering, 27(7), 1107-1112.
[33] Wu, K.S. (1998). An order policy for items with Weibull distribution deterioration under permissible delay in payments. Tamsui Oxford Journal of Mathematical Science, 14, 39-54.
[34] Yang, C.T. (2014). An inventory model with stock-dependent demand rate and stock-dependent holding cost rate. International Journal of Production Economics, 155, 214-221.
[35] Yang, H.L., Teng, J.T. and Chern, M.S. (2010). An inventory model under inflation for deteriorating items with stock dependent consumption rate and partial backlogging shortages. International Journal of Production Economics, 123, 8-19.

CHAPTER-1.2

Use of Electronic Resources by Uttaranchal University Research Scholars: A Study

Kishor Bhatt[1], Dr. Sapna Sharma[2], Dr. Bharat VPS Rawat[3]
[1]Librarian, JBIT Group of Institution, Dehradun, India,248197
[2]Assistant Professor, Department of Library and Information Science, Swami Vivekananda Subharti University, Meerut, India
[3]Associate Professor, JB Institute of Technology, Dehradun, Uttrakhand, India

Abstract- *The study sought to determine how the research students at Uttaranchal University used electronic resources. A questionnaire was sent to the Research Scholars to collect the needed information. The fifty questionnaire was sent to the Research Scholar of Uttaranchal University and forty completely filled were obtained. The majority of respondents are aware of the existence of e-resources, according to the research study the results show that 28.50% of respondents exclusively want access to electronic versions, while 53.50% of users prefer reading physical journals. However, 18% of respondents want to utilize electronic and printed editions both simultaneously. 18 % of those surveyed utilized online resources to write their papers. The study demonstrates that many respondents look for online resources when writing research papers.*

Keywords: Internet, email, search engines, library, user research, Uttaranchal University

Introduction

Due to the ease of access to many resources made possible by the use of the Internet in educational settings, information exchange has increased tremendously**.** Widespread adoption of this sharing has also resulted in further advantages because these resources may now be accessed from any location at any time. Broad changes in communication technology shaped the twentieth century. The most significant advancement in information technology that has affected scholarly communication this century is its creation and usage. Information processing using computers has given rise to several new goods and services. Both in terms of collection growth and service delivery models, libraries have seen significant transformations in recent years. As a result, libraries are utilizing technology to improve scholarly information management and speed up access to academic content that is not locally held. According to this report, practically all college students who have access to online resources opt to use them for their studies rather than going to traditional libraries. Cheung and Huang (2005) highlighted how the Internet can be a powerful teaching tool in higher education and suggested that more university instructors make their course materials available online. The use of electronic media to deliver information is replacing print media more and more (Sharma, 2009). The transition of print to multimedia, according to Ani (2008), "has provided users with new tools and applications for information finding and retrieval, aside from resulting in a rise of electronic information.". When used in conjunction with print-based resources in a typical library context, electronic resources are priceless research aids.

According to Dadzie (2007), print-based resources in a typical library context complement

electronic resources as excellent research tools. Her list of benefits from them includes access to information that could be unavailable to the user owing to finances or location, access to more recent information, and availability of broad linkages to other similar sites.

Due to the fast growth and advancement of technological information technology, it is now possible to think of new ways of arranging the collections and services the library has traditionally offered. As libraries enter a time of financial crisis in collection development, these new technologies offer the possibility of cost reduction and a revolution in information access. According to Naidu (2007), the primary benefits that draw in research researchers are prompt publishing and desktop accessibility.

Peng et al. (2006) showed a correlation between perceptions of the Internet and online attitudes and self-efficacy in their research of university students' attitudes and self-efficacy towards the Internet. They demonstrated the benefit to children using the Internet as a helpful tool or technology. Numerous other essential studies explore the impact of the Internet and electronic resources on university students' self-efficacy and performance in addition to those that have already been mentioned (Crews & Feinberg, 2002; Wu & Tsai, 2006; Wen & Tsai, 2006; Perry et al., 1998; Wainer et al., 2008; Odell et al., 2000; Crouch, 2001; Mohammed & Al-Karaki, 2008).

E-RESOURCES FOR RESEARCHERS

Information is represented electronically via electronic resources. They come in various formats, including electronic books, digital libraries, online journals and magazines, online instructors, and online tests. These online resources have become a source of information due to their efficient presentation using multimedia capabilities. Information is delivered through electronic resources in the form of full-text databases, electronic journals, picture collections, multimedia on CD, tape, the Internet, and online, among other formats. E-resources include e-journals, e-discussion boards, e-news, data archives, online chat rooms, and email. Electronic information sources include a wide range of items, such as CD-ROMs, databases, mailing lists, and electronic magazines, all which computers may utilize and occasionally update. Computers and the Internet, the most efficient communication technologies, are a staple of modern life and are now crucial educational resources. The Internet is a highly potent information system because it facilitates the movement of information between many sites. Because it is one of the simplest, quickest, and least expensive ways to get vital information, people of all ages and occupations, students and academics who do scientific study and create projects, enjoy utilizing the Internet (Cloud, 1989).

The question of whether the source being cited is reliable and reputable has been brought up, even though the Internet is a crucial resource for students. This is because, unlike the scientific and professional publications produced by scientific institutions, corporate world, and organizations known to the general public, there is no control over every specific information released through the Web.

The control element consists of editors and referees and is absent from other journals and

books published by for-profit organizations. Anybody may submit any information to numerous websites on the Internet without any restrictions, and many sites that are regarded as credible only allow open access due to security restrictions (IP limitation, membership, etc.) or commercial needs. Students are deprived of these websites and have their accessibility restricted as a result. Database of scholarly journals, the quantity of publications included and the methods used to evaluate them in order to create a global academic index are connected to the effectiveness of Academic Journals Database. They offer a wealth of specialized knowledge and are seriously utilized by professors and students alike. They are categorized into categories based on the many disciplines and serve as crucial reference resources for these individuals conducting in-depth study into various subject areas. Internet search, search engines are the most often utilized sources for student projects since they are free access websites. Some of them are customized tools that provide several search engines, like "Copernic," while many of them have open access on Internet Explorer programmes. The majority of the time, students use the resources obtained through these engines to acquire the data they need for their projects. The information gleaned from these sources varies depending on the academic level of the student and the significance of the project's subject matter. Directly accessible resources can deliver more accurate search results for particular document formats, including those with the pdf, ppt, and doc extensions, by utilizing various criteria in the advanced search tabs. This enables the extraction of undesired resources or access to the information that is needed.

Remote Education With the aid of today's cutting-edge technologies, students may access distance learning at any time and from any location, allowing the student and instructor to interact at the same or separate times without the need for physical closeness. Web-based training serves as the foundation for the infrastructure of remote education corporation's information management system's dependability and organization determine how useful and trustworthy the present information is. Systems for managing information should be adaptable, simple to comprehend, dynamic, managed, and appreciated by users. They should also have a culture that encourages learning.

Associated Software Students in many academic disciplines at universities utilise a wide variety of software. After graduation, they are tied to a particular discipline of science or employed as part of the present educational curriculum. The information needed for projects and commercial life is included in this programme. Computer programmes are widely used for business, but their use for educational purposes is strictly restricted and requires a license.

About Uttaranchal University

Since its beginnings, Uttaranchal University has gone a long way in offering top-notch interdisciplinary education. Under sections 2(f) and 12(B) of the UGC Act, 1956, as well as by other statutory authorities of the State and the Country, Uttaranchal University has been granted recognition by the UGC. The National Assessment and Accreditation Council (NAAC) has awarded the University its top "A+ Grade" of accreditation. As the first University in the State of Uttarakhand to obtain an NAAC A+ grade during the initial

accreditation cycle, Uttaranchal University has made history. The University is now firmly established as one of the top 5% HEIs in the country. The university is unwavering in its commitment to its objective to offer the best experience to all of its students, whether regional, national, or worldwide, through high-quality instruction, funding for research and innovation, and instilling in them the meaning of the aforementioned Sanskrit Shloka:

Review of Literature

According to a 2005 study by Ali, 83% of the students polled said that accessing this source had saved them time and made their lives easier. According to two thirds of those polled, they would wait for the CD-ROM to become free rather than use the print tool if it was busy. However, a study of online scientific information searching in Delhi's science and technology libraries reveals that a sizable portion of users (nearly 60%) encounter a variety of issues when browsing electronic information, including a lack of knowledge about the resources, untrained staff, and subpar terminals. Studies on the usage of electronic resources by instructors, students, and researchers at universities and research institutions have also been conducted. 78% of the population of the.

Kebede (2002) conducted a study on ICT usage in 10 public library services in Africa. Although most libraries had internet access, the study showed that only few were providing patrons with web-based information services. However, the study identifies four obstacles to the efficient provision of electronic resources in those libraries, including a lack of strategic planning, a lack of adequate or dependable funding, a lack of use of the Internet to provide information services to users, and a lack of consistent training for users in new ICT services.

Ojo and Akande (2005) investigated students' access to, use of, and understanding of electronic information resources at the University College Hospital (UCH) Ibadan, Nigeria, using a survey of 350 respondents. The survey found that there is not a lot of utilization of electronic information resources. The inability of medical students to use electronic resources effectively due to a lack of information retrieval skills is a significant issue.

Jagboro (2003) had also emphasized how users were becoming to rely on and see electronic resources. She discovered that 45.2% of respondents used cybercafés to access electronic resources in a survey she performed at different Nigerian universities. However, she claims that this attitude is a result of cybercafés being close to user facilities.

Ajuwon (2003) also conducted a research on how University College Hospital, Ibadan students studying health sciences use ICTs. The results of this study showed that 57% of the sampled students were unable to operate a computer, and that poor database utilisation was caused by a lack of knowledge, access to computers, inadequate training, and the high cost of service. Since using electronic resources increases productivity in work, learning, teaching, and research, it is assumed in all the studies mentioned above that doing so is highly desirable**.**

Objectives of the Study

1. To determine how well users are aware of the usage and benefits of the many online resources that are available.
2. To determine how frequently people use e-resources.
3. To learn about the challenges researchers, have while utilizing and accessing online resources.

Research Methodology

A systematic questionnaire was developed to gather information from e-resource users while keeping the aforementioned goals in mind. Numerous questions about awareness of and usage of electronic resources are included in the questionnaire. 50 questionnaires were given to the Researchers in total for this purpose. An analysis, tabulation, interpretation, and presentation of the data were done using the 40 valid questionnaires out of the 50.

DataAnalysis

A research paper's data analysis is an essential stage. It is the connection between unprocessed data and noteworthy findings that lead to conclusions. This analysis method must be goal oriented.

Population Study

Table1.Sexwise distribution of Respondents

Gender	No. of Respondents	Percentage
Male	25	62%
Female	15	38%
Total	40	100%

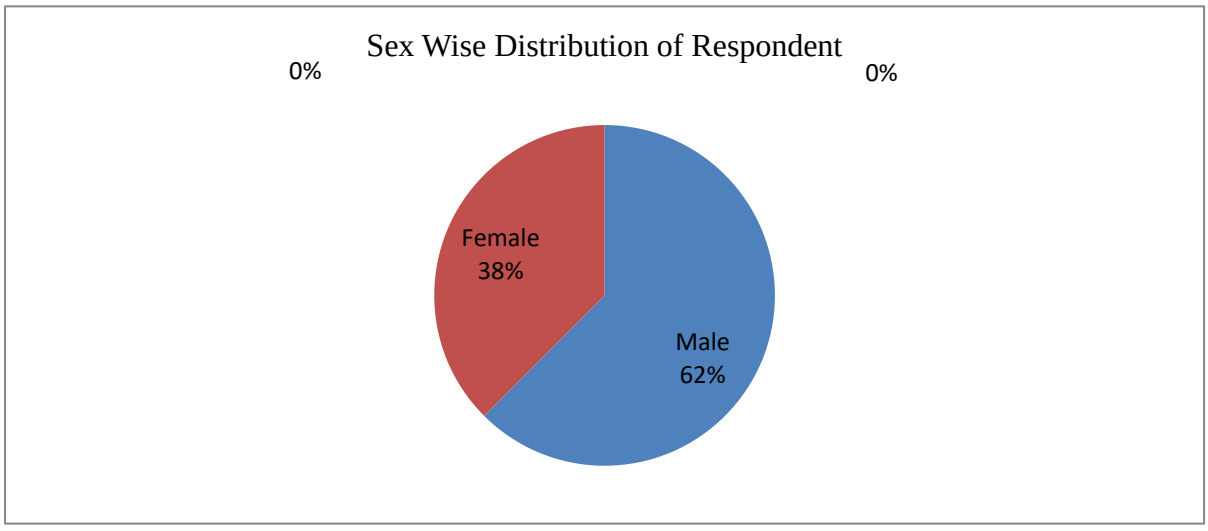


Fig. 1 identifying the sex

The questionnaire's personal detail section contains data from Table 1 identifying the sex. Table 1 demonstrates that only 38% of the populations investigated were female, with 62% of the populations using the e-resources offered by the library for a variety of objectives.

Table:2 Awareness about E-resources

Gender	Aware	Not aware
Male	21(52.50%)	4(10.00%)
Female	13(32.50%)	2(05.00%)
Total	34(85.00%)	6(15.00%)

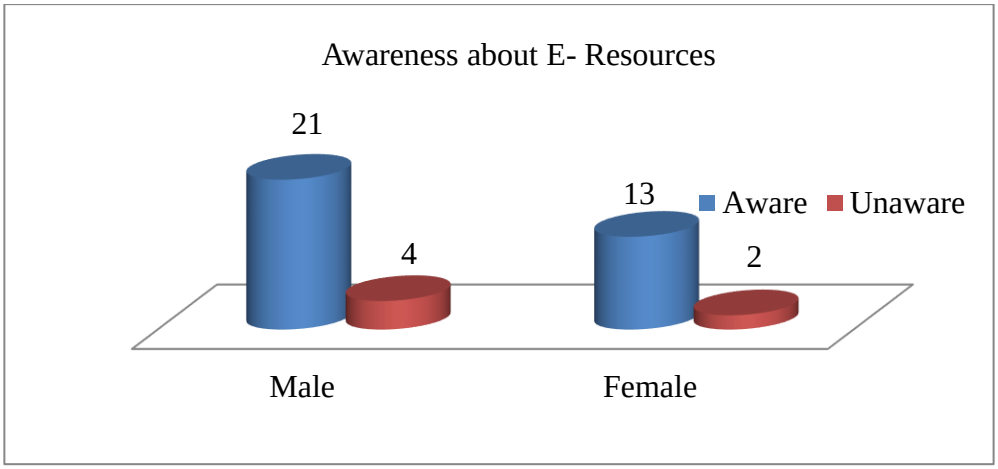
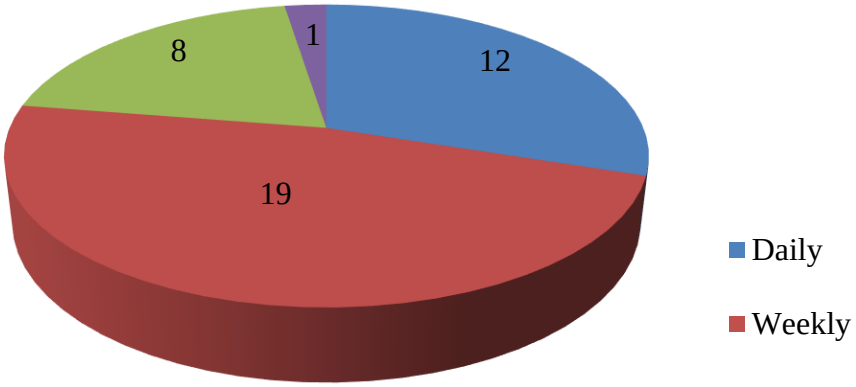


Fig. 2 displays the respondents' knowledge of e-resources, showing that 52.50 % of male respondents were aware of their availability, compared to 32.50 % of female respondents. Male respondents are more knowledgeable about online resources than female responders.

Table: 3 Frequency of Using E-resources.

Duration	Number	Percentage
Daily	12	30%
Weekly	19	47.5 %
Monthly	8	20%
Not Use	1	2.5 %
Total	40	100%



Frequence of Using E- Resource

In response to that inquiry, how often do you use internet resources? The respondents utilized several types of responses (Table 4). Most respondents to the poll accessed internet resources every week (47.5 %) and every day (30%). 20%of respondents used internet resources just once a month and1 (2.5 %) of Scholar did not use E-resources.

Table: 4 Problems Faced of Accessing E-resources

Reason	Number	Percentage
Not many E-resources available in my subject	28	70
No assistance was provided by the information professionals	6	15
Lack of training	6	15

Table:5 Difficulties of Accessing E-resources

Even though e-resources are more prevalent in the academic and research sectors, most users reported having trouble using them. Most respondents do not feel there are enough e-resources available for their particular subject, followed by coverage of e-resources that are inappropriate for my study field, little support from information experts, and a lack of training.

Conclusion

The fast growth of ICT tools, mainly the Internet and electronic resources, has changed scholarly information of traditional research communication methods. In the present scenario, the Internet has emerged as the most potent medium for storing and retrieving information. The study showed that electronic resources had significantly impacted users of Uttaranchal University in their research and development. It is clear from the study that at present time the youth has accepted electronic resources, but the volume of frequent usage of e-resources among the users is at the optimum level. Many respondents are unaware and have not used online thesis/dissertations, databases, abstracts/indexes, or OPAC, which are relevant for research. So, the library can take the initiative to organize orientation programs and user awareness programs in this area.

References

[1] Akbulut, Y. (2008). Exploration of the attitudes of freshman foreign language students toward using computers at a Turkish state university. Turkish Online Journal of Educational Technology, 7, 18-31.
[2] Barak, A. & Sadovsky, Y. (2008). Internet use and personal empowerment of hearing- impaired adolescents. Computers in Human Behavior, 24, 1802-1815.
[3] Bharat. (2021). Social Media exposure and Psychological problems during COVID-19 outbreak: A cross-sectional study. International Journal of Psychosocial Rehabilitation, 25(2), 346-351.
Retrieved from https://www.psychosocial.com/article/PR320037/37891/
[4] Brophy, J. & Bawden, D. (2005). Is Google enough? Comparison of an internet search engine with academic library resources, Aslib Proceedings, 57, 498-512.
[5] Cebeci, Z. & Bek, Y. (1999). İnternet Bilgi Kaynaklarının Kalitesi: Değerlendirme Ölçütleri. In 4th Internet Konferansı.
[6] Chang, M. K. & Law, S. P. M. (2008). Factor structure for Young's Internet Addiction Test: A confirmatory study. Computers in Human Behavior, 24, 2597-2619.
[7] Chen, Y. F. &Peng, S. S. (2008). University students' Internet use and its relationships with academic performance, interpersonal relationships, psychosocial adjustment, and self- evaluation, Cyberpsychology& Behavior, 11, 467-469.
[8] Cheung, W. & Huang, W. (2005). Proposing a framework to assess Internet usage in university education: an empirical investigation from a student's perspective, British Journal of Educational Technology, 36, 237-253.
[9] Cloud, C. C. (1989). Network Ethics: Access, Consent and Informed Community. USA: Westview Press. Crews, M. & Feinberg, M. (2002). Perceptions of university students regarding the digital divide. Social Science Computer Review, 20, 116-123.
[10] Crouch, M. A. (2001). Using the Internet to facilitate student learning in a large therapeutics course: A three year perspective. American Journal of Pharmaceutical Education, 65, 7-13.
[11] Dhiman, D. (2022). Condition of Women Prisoners in Model Jail, Chandigarh: A Communication Study. Condition of Women Prisoners in Model Jail, Chandigarh: A Communication Study (August 26, 2022).
[12] Malik, D., Singh, P., &Dhiman, D. (2022). Science Communication in India: Current Trends and Future Vision. Science Communication in India: Current Trends and Future Vision (June 10, 2022).
[13] Dhiman, B., & Malik, P. S. (2021). Psychosocial Impact of Web Series and Streaming Content: A Study on Indian Youth. Global Media Journal, 19(46), 1-7.
[14] Dhiman, B. (2019). Effects of Online News Applications for Android–A Critical Analysis. European Journal of Business and Social Sciences, 7(2), 815-819.
[15] Dhiman, B. (2021). The Practice of Media Education and Media Research: A Review on Five Asian Countries. Global Media Journal, 19(44), 1-7.
[15] Dr. Abid Ali, Bharat. (2021). Impact of Smartphone: A Review on Negative Effects on Students. PalArch's Journal of Archaeology of Egypt / Egyptology, 18(4), 5710-5718.
[16] Dr. Abid Ali, Bharat. (2020). Influence of Social Media in Developing Social Anxiety: A Study of Kurukshetra University Students. PalArch's Journal of Archaeology of Egypt / Egyptology,17(12),1585-1592.

INTEGRATED SOLUTIONS: ELECTRONICS & COMMUNICATION ENGINEERING

CHAPTER-2.1

Improving TCP Communication in Cognitive Radio Networks

Bharat Pal Singh[1], Shikha Tayal[2]
[1]Assistant Professor, JB Institute of Technology, Dehradun, India, Pin- 248197
[2]AssociateProfessor, JB Institute of Technology, Dehradun, India, Pin- 248197
Email of corresponding Author:1179bharat@gmail.com

Abstract- *Cognitive Radio Network (CRN) is an extremely promising technology for future networks, given the limited availability of spectrum resources. CRN has the potential to utilize channels effectively by enabling systems to be context-aware and capable of reconfiguring themselves based on their surroundings, as well as their own properties such as spectrum availability, traffic load, congestion levels, network topology, and wireless channel propagation characteristics. In the realm of cognitive radio, the role of TCP assumes great significance. Ensuring seamless handling of communication channels by Primary Users, whether they are occupying or releasing them, is of utmost importance in CRN when secondary users are utilizing those channels. To address this challenge, effective cognitive communication between TCP and MAC layers is indispensable. This research paper focuses on investigating this issue in order to overcome the decay in TCP throughput within cognitive radio networks, ultimately aiming to enhance communication efficiency.*

Keywords- Cognitive Radio, TCP, MAC, Spectrum sensing, wireless communication

INTRODUCTION

Cognitive Radio Networks (CRNs) rely on the collaboration between the Primary User (PU) with licensed bands and the Secondary User (SU) with unlicensed bands to efficiently utilize available bandwidth. According to statistics from the Federal Communication Commission (FCC) [2], spectrum utilization in different geographical regions can range from 15% to 85%. CRNs improve bandwidth utilization by allowing SUs to utilize idle bands. SUs employ opportunistic spectrum access (OSA) mechanisms [3], [4], [5] to transmit data when spectrum opportunities arise, as long as the licensed bands are not in use by the PU. However, it is important to note that the PU holds the highest priority and can influence SU traffic by accessing or vacating its bandwidth.

The presence of PUs sets CRNs apart from other wireless networks. Ideally, SUs should avoid interfering with PUs and cease transmitting data when the PU intends to use the same bandwidth. The main functions in CRNs include spectrum sensing, spectrum management, spectrum mobility, and spectrum sharing [3]. SUs create channel sensing schedules to identify the best available channel and manage it to minimize interference from PUs, following the assigned access schedule. In wireless networks, the decay of TCP throughput is primarily caused by environmental factors. Parameters from the MAC/PHY layer are communicated to the TCP layer to enhance throughput. However, it is the transmission behavior of TCP that plays a key role in throughput decay, rather than the MAC layer alone. The MAC/PHY layer information is responsible for enabling SUs to avoid interference from PUs. Hence, the proposed solution investigates cognitive communication between TCP and

MAC, utilizing CR device information in CRNs to enhance communication efficiency.

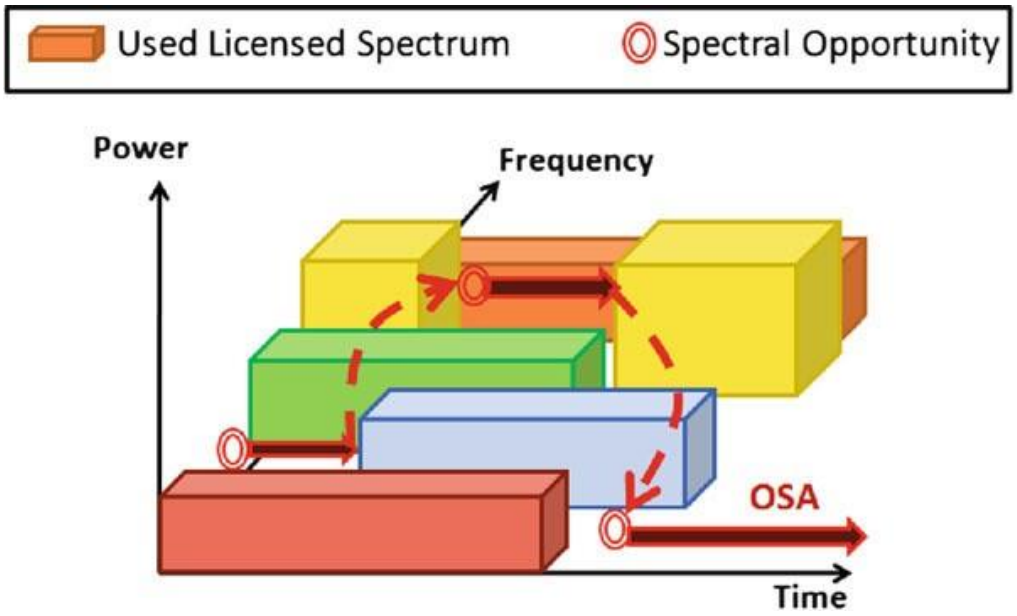


Fig1. Opportunistic Spectrum Access tracks

BACKGROUND & RELATED WORKS

Cognitive radio

Cognitive radio (CR) [6] is a highly promising technology in the field of communications and networking, addressing the issue of spectrum scarcity. In CR communication, the radio spectrum is utilized opportunistically, taking advantage of unused channels while primary users (PUs) are not actively using them. CR-enabled devices continuously monitor the radio environment to identify spectrum holes, which are unused channels at specific times and locations. These spectrum holes are utilized for communication among CR devices.

As secondary users, CR users must monitor the used bands to detect any activity by primary users. When primary users appear, CR users need to take appropriate measures to avoid interference, such as switching to a different, unoccupied frequency band or reducing their transmission power. Understanding the performance of CR systems is crucial, particularly their impact on the performance of user applications and the overall user experience. Cognitive radio can be seen as a form of software-defined radio (SDR), where a cognitive cycle enables wireless terminals to be aware of their radio environment and adapt accordingly [7]. This cognitive capability allows CR devices to intelligently respond to changes in the spectrum availability and optimize their operations based on real-time conditions.

TCP over Cognitive Radio networks

TCP is considered inefficient in Cognitive Radio (CR) networks due to the following reasons [8]:

Channels with variable characteristics:

CR-enabled devices continuously monitor their radio environment to detect spectrum holes

for opportunistic use. However, each channel in a Cognitive Radio (CR) network can have varying characteristics in terms of bandwidth, loss, and delay. The nature of TCP makes it slow to adapt to frequent changes in bandwidth and sensitive to loss and delay, leading to efficiency deterioration in CR networks.

One challenge arises from temporary disconnections due to spectrum sensing. CR devices alternate between sensing mode and transmission mode. During sensing mode, the devices do not transmit data, resulting in a sudden increase in round trip time (RTT). If TCP's retransmission timeout (RTO) timer TRTO is set to a value smaller than the RTT plus an offset (To), timeouts can occur during the spectrum sensing period. As a result, TCP sets its congestion window (cwnd) to 1 and reduces the slow start threshold (ssthresh) to half of its previous value, entering the slow-start phase. This leads to underutilization of the available bandwidth, as illustrated in [9].

Another challenge arises during spectrum handover when primary users appear. When a primary user becomes active on a channel, secondary users must vacate that channel and find an alternative channel to use. This process introduces delays and disconnections as CR devices transition from one channel to another. These transitions can affect TCP's performance, causing disruptions and reduced efficiency in utilizing available bandwidth.

To address these challenges, research efforts are focused on developing enhanced transport layer protocols that are better suited for CR networks. These protocols aim to improve TCP's adaptability to dynamic spectrum conditions, minimize the impact of temporary disconnections, and optimize the handover process during primary user appearances. By improving TCP's responsiveness and resilience to changes in the CR environment, the efficiency and performance of communication in CR networks can be enhanced.

CR MAC

In cognitive radio (CR) networks, Medium Access Control (MAC) protocols play a crucial role in facilitating efficient spectrum sharing between primary users (PUs) and secondary users (SUs). The state-of-the-art CR MAC protocols, as outlined in [10], can be categorized into two major types: overlay MAC and underlay MAC.

1. Overlay MAC: In overlay MAC, SUs opportunistically access the licensed spectrum that is not being used by PUs. However, SUs must vacate the spectrum when PUs return to use it. Overlay MAC protocols enable SUs to utilize idle spectrum bands without causing harmful interference to PUs.

2. Underlay MAC: In underlay MAC, SUs are allowed to continue using the spectrum even when PUs are present. However, the interference caused by SUs to PUs must be carefully controlled and kept below predefined interference thresholds. Underlay MAC protocols ensure that SUs coexist with PUs while maintaining acceptable levels of interference.

The CR MAC serves as a crucial link between the CR physical layer and the CR network layer, facilitating effective communication and spectrum utilization. Its functions include:

1. Channel Selection and Access: The CR MAC utilizes spectrum sensing information from the CR physical layer to assess channel availability and characteristics. It determines which channel to use and when to access it based on the observed spectrum availability and the requirements of SUs.

2. Channel Characterization and Reporting: The CR MAC provides the CR network layer with information about channel characteristics, such as channel quality and occupancy. This information helps the network layer in making informed decisions regarding routing paths, channel selection for specific quality-of-service (QoS) requirements, and overall network optimization.

3. Coordination and Interference Control: The CR MAC ensures coordination among SUs to prevent harmful interference to PUs. In overlay MAC, it enforces spectrum vacancy when PUs return, while in underlay MAC, it employs mechanisms to control and limit interference levels to maintain PU's quality of service.

In summary, the CR MAC protocols in CR networks facilitate efficient spectrum access, channel selection, interference control, and coordination between the physical and network layers. These protocols play a critical role in optimizing spectrum utilization and enabling seamless coexistence between primary and secondary users in CR environments.

In cognitive radio (CR) networks, interference control and avoidance are crucial for enabling spectrum sharing between primary users (PUs) and secondary users (SUs). The CR MAC protocols address these aspects to ensure efficient and coordinated operation:

1. Interference Control and Avoidance for PUs: The objective is to enable SUs to share the spectrum with PUs without causing harmful interference. Two modes of spectrum sharing are commonly used:

a. Overlay Mode: In this mode, SUs opportunistically access the spectrum that is not being used by PUs. However, SUs must vacate the channel as soon as PUs return to use it. This ensures that PUs have priority access to their licensed spectrum.

b. Underlay Mode: In this mode, SUs are allowed to operate in the same channel as PUs, but the interference caused by SUs to PUs must be controlled and kept below a predefined threshold. Underlay MAC protocols employ various interference management techniques, such as power control, adaptive modulation, and coding, to maintain acceptable interference levels and protect PUs' communication quality.

2. Collision Avoidance Amongst SUs: Since multiple SUs may coexist in a CR network, there is a possibility of collisions if they simultaneously access the same spectrum band based on their spectrum-sensing results. The CR MAC protocols include mechanisms to control spectrum access and avoid collisions among SUs. This involves techniques such as contention-based access, random access protocols, or coordinated access schemes to ensure that SUs do not interfere with each other when accessing the spectrum.

By addressing interference control and collision avoidance, the CR MAC protocols facilitate

efficient spectrum sharing among SUs while minimizing disruptions to PU communication. These mechanisms help in optimizing spectrum utilization, ensuring fair access, and maintaining overall network performance in CR networks.

Related Work

Since the introduction of cognitive radio (CR) by Mitola [7], significant research efforts have been devoted to addressing TCP-related issues in CR networks. Several solutions have been proposed in this field, aiming to enhance TCP performance and throughput. Here are a few examples:

1. Cognitive TCP: A cognitive TCP solution, as presented in [12], suggests adapting MAC/PHY parameters to improve TCP throughput. This approach dynamically adjusts codec, modulation schemes in the physical layer, and frame size in the MAC layer to maximize TCP performance based on the current spectrum conditions.

2. TCPCRAHN: TCPCRAHN [13] is a window-based, TCP-like spectrum-aware transport layer protocol designed specifically for CR ad-hoc networks. It takes into account different spectrum-specific conditions such as spectrum sensing and switching, sudden appearance of primary users (PUs), and movement of secondary users (SUs). By considering these factors, TCPCRAHN enables state-dependent recovery actions to maintain TCP performance in CR networks.

These solutions focus on the influence of lower layers, such as the MAC and physical layers, on TCP performance. They aim to mitigate TCP throughput decay caused by varying bandwidth in CR environments. Specifically, the decay problem is attributed to improper congestion window decay during the passage of TCP flows through CR links. This decay is considered as a form of slight-level congestive loss for TCP.

The research in this area aims to improve TCP performance in CR networks by addressing the unique challenges and characteristics of the cognitive radio environment. By considering the dynamic nature of the spectrum, the impact of primary users, and the mobility of secondary users, these solutions strive to optimize TCP throughput and enhance the overall efficiency of communication in CR networks.

PROPOSED WORK

As shown in Fig.2, the characteristics and operation of the CR-MAC protocol, which is a cognitive radio-based MAC protocol designed to address issues related to channel access and interference between primary users (PUs) and secondary users (SUs). The CR-MAC protocol aims to optimize bandwidth capacity and minimize packet loss for SUs while ensuring proper channel access for PUs. Here is a summary of the key points mentioned:

1. Fixed MAC Super-frame Size: The secondary user has a predetermined MAC super-frame size and scans all channels to determine which channel to access at the beginning of each super-frame.

2. Orthogonal Channels: N orthogonal channels are available for both primary and secondary

users to use without causing interference between each other. The secondary user can access multiple channels simultaneously, and the total bandwidth capacity is the aggregate of all the channels it uses.

3. Acting Channels: Whenever a primary user wants to access a channel currently being used by a secondary user, the secondary user vacates all the channels it is utilizing to give access to the primary user.

4. Presence of Primary User Transmitter-Receiver Pair: Channels must contain at least one primary user transmitter-receiver pair to ensure legitimate primary user activity.

5. MAC Layer Information: The MAC layer provides historical channel utilization information about primary users and real-time channel availability to secondary users. This information helps secondary users make informed decisions about channel access and reduces the chances of interference.

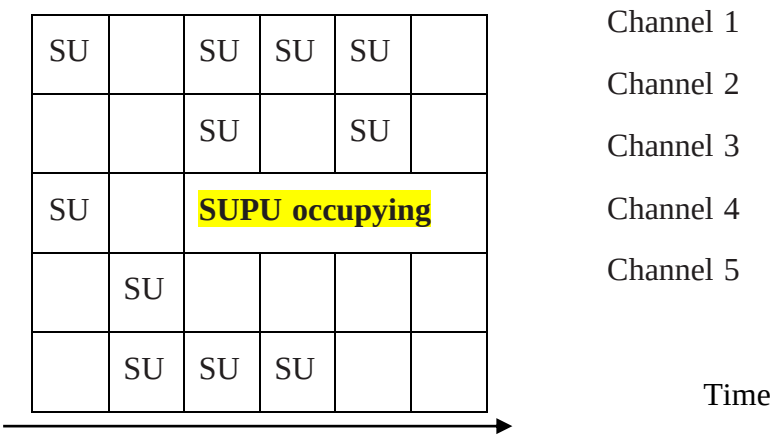


Fig2. PU Occupying Channel in MAC Super Frame

The importance of considering the historical channel utilization of primary users and the current channel availability, when addressing TCP throughput decay issues. The long-term historical information helps identify general trends and bandwidth capacity, while short-term information accounts for temporary variations and potential errors in estimating parameters such as round-trip time (RTT) during low bandwidth capacity periods.

To facilitate cognitive communication between TCP and MAC layers, the following information is required:

I. History of Primary User Channel Access: Statistics about when primary users access channels while secondary users are using them.

II. Available Channels: Information about the available channels helps secondary users determine the bandwidth capacity and reduce packet loss.

III. Identifying TCP Throughput Decay: Analyzing the provided information from cognitive radio devices helps identify instances when TCP throughput decay occurs and take appropriate measures.

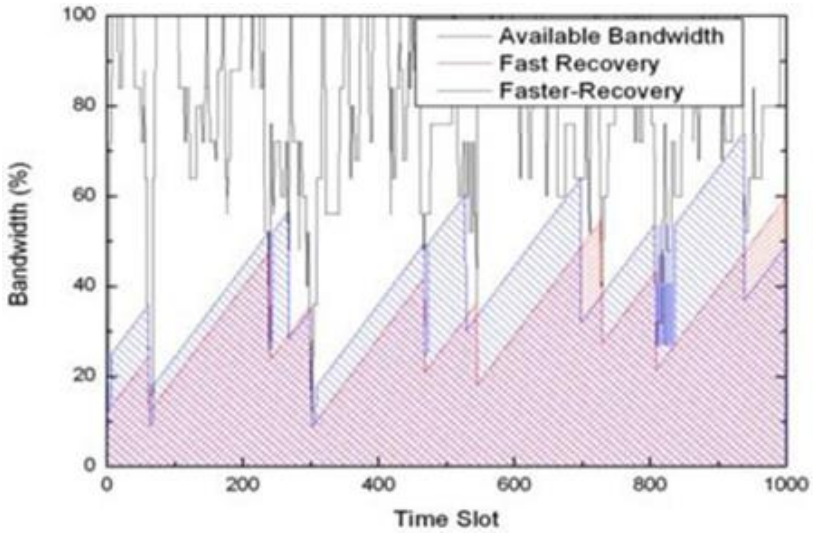


Fig3. Faster-recovery mechanism [1].

Fig. 3 illustrates the idea of the faster recovery mechanism for retransmitting lost packets due to primary user interference, avoiding starvation of TCP clients, and implementing a faster recovery mechanism in mild-congestion situations. These mechanisms aim to maintain TCP performance and prevent unnecessary congestion window reductions.

Overall, the CR-MAC protocol aims to optimize channel access and improve the bandwidth capacity and packet loss performance of secondary users while considering the interference caused by primary users in cognitive radio networks.

Table 1- Parameters of Simulation

Parameter	Value
Bandwidth per channel	100 Kbps, 1Mbps
Total Channel	10
PU Influence	1%,75%
Sensing Interval	1,2 seconds

RESULTS

Fig4, illustrates the performance levels achieved in overcoming TCP throughput decay in cognitive radio networks when dealing with primary user channel occupancy or release while the secondary user is using it. The study was conducted using the NS-2 simulation tool. Here are some key points mentioned:

1. Number of Channels: The cognitive radio (CR) link consists of 10 channels that can be utilized by secondary users.

2. Simulated Bandwidth: Each channel has a fixed bandwidth throughout the simulation.

3. Secondary User Channel Sensing: The secondary user (SU) senses a channel every 2 seconds, following the IEEE 802.22 standard, which coincides with the length of the MAC super-frame.

4. Simulation Parameters: The specific simulation parameters used are provided in Table2, which likely includes details about the network configuration, traffic patterns, and performance metrics.

5. TCP Throughput Improvement: The figure shows that there is a slight decrease in the improvement of TCP throughput as the channel bandwidth increases. This means that higher channel bandwidth allows the MAC layer to resend collided packets more quickly, resulting in fewer packet timeout events. Consequently, the TCP experiences fewer packet loss events caused by primary user influence.

The information implies that higher channel bandwidth facilitates faster recovery from collisions, leading to improved TCP throughput and reduced packet loss. However, the figure suggests that the rate of improvement in TCP throughput diminishes as the channel bandwidth increases; indicating a potential saturation point where further increases in bandwidth yield diminishing returns.

It's important to note that without specific details or the figure itself, it is challenging to provide a more precise interpretation or analysis of the results presented.

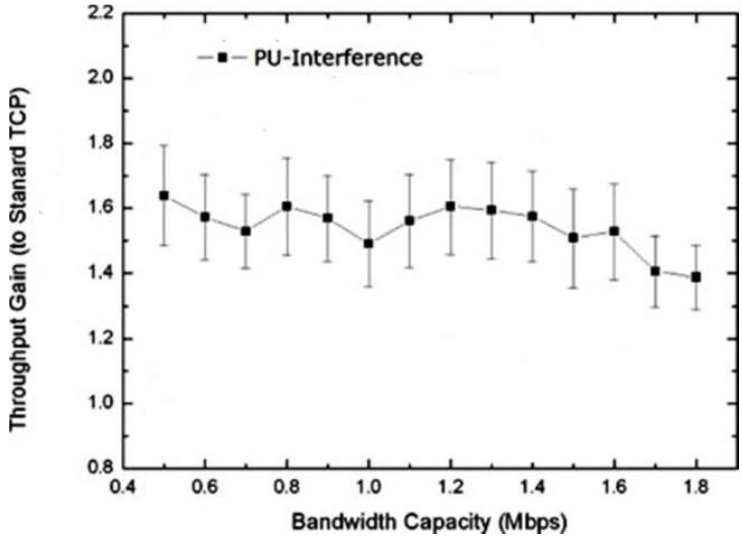


Fig4. Performance of PU in different Bandwidth Capacity.

CONCLUSION

In this paper, we explore the issue of TCP throughput degradation in cognitive radio networks caused by primary users (PUs) and secondary users (SUs). We present a novel approach that leverages cognitive communication between TCP and MAC layers to enhance TCP performance in these networks. Our proposed solution is evaluated through extensive simulations, and the results depicted in Figure 5 demonstrate its substantial effectiveness in improving TCP throughput under various scenarios. Furthermore, we assess the performance of our mechanism and observe significant enhancements in terms of link utilization efficiency

when compared to standard TCP. For future work, we plan to enhance our simulator by incorporating additional details related to micro-mobility and incorporating new cognitive radio parameters to further enhance the overall system performance.

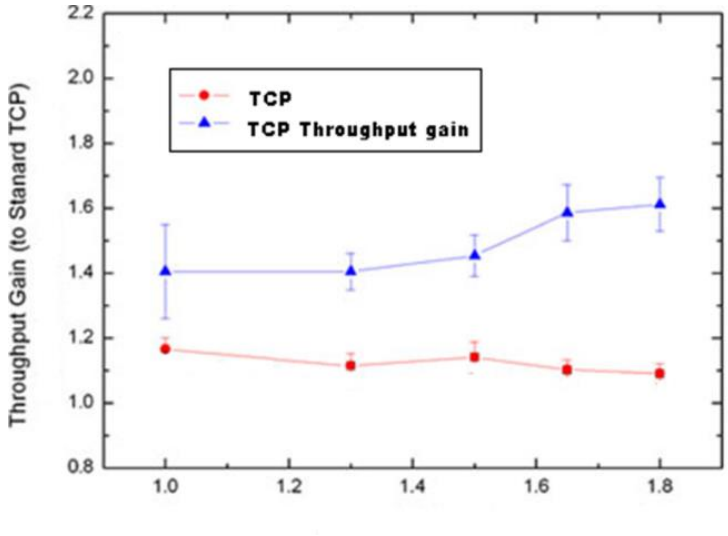


Fig5. Performance of TCP in sensing interval after throughput gain in CRN.

REFERENCES

[1] Cheng Yu-Chun, Cheng-Fu Chou, Eric Hsiaokuang Wu, and Gen-Huey Chen "A Cognitive TCP Design for a Cognitive Radio Network with an Unstable-Bandwidth Link" IEEE TRANSACTIONS ON COMPUTERS, VOL. 64, NO. 10,
[2] OCTOBER 2015
[3] "Spectrum policy task force," Federal Commun. Comm., Washington,DC, USA, Rep. ET Docket., Nov. 2002.
[4] I. F. Akyildiz, W.-Y. Lee, M. C. Vuran, and S. Mohanty, "NeXt generation/dynamic spectrum access/cognitive radio wireless networks: A survey," Comput. Netw., vol. 50, pp. 2127– 2159, 2006.
[5] J. D. Poston and W. D. Horne, "Discontiguous OFDM considerations for dynamic spectrum access in idle TV channels," in Proc. First IEEE Int. Symp. New Frontiers Dynamic Spectrum Access Netw.,
[6] J. Juncheng, Z. Qian, and S. Xuemin, "HC-MAC: A hardwareconstrained cognitive MAC for efficient spectrum management," IEEE J. Select. Areas Commun., vol. 26, no. 1, pp. 106–117, Jan. 2008.
[7] S. Haykin, "Cognitive radio: Brain-empowered wireless communications," IEEE J. Select. Areas Commun., vol. 23, no. 2, pp. 201–220,Feb. 2005.
[8] J. Mitola III and G.Q. Maguire Jr. "Cognitive radio: making software radios more personal." IEEE Personal Communications, 6(4):13-18, August 1999.
[9] Y. R. KondaReddy and P. Agrawal. "Effect of Dynamic Spectrum Access on Transport Control Protocol Performance." IEEE GLOBECOM 2009,Nov. 30 - Dec. 4 2009.
[10] "IEEE P802.11 Task Group af - Wireless LAN in the TV White Space."
[11] T. Issariyakul, L. S. Pillutla, and V. Krishnamurthy, "Tuning radio resource in an overlay cognitive radio network for TCP: Greed isn't good," IEEE Commun. Mag., vol. 47, no. 7, pp. 57–63, Jul. 2009.
[12] C. Yu-Chun, E. H. Wu, and C. Gen-Huey, "A new wireless TCP issue in cognitive radio networks," in Proc. 1st Int. Conf. Netw.Comput., 2010, pp. 49–54.
[13] C. Luo, F. R. Yu, H. Ji, and V. C. M. Leung, "Cross-layer design for TCP performance improvement in cognitive radio networks," IEEE Trans. Veh. Technol., vol. 59, no. 5, pp. 2485– 2495, Jun. 2010.
[14] K. R. Chowdhury, M. D. Felice, and I. F. Akyildiz, "TCP CRAHN: A transport control protocol for cognitive radio ad hocnetworks," IEEE Trans. Mobile Comput., vol. 12, no. 4, pp. 790–803, Apr.2013.

CHAPTER-2.2

Human-Computer Interaction and User Interfaces for the Internet of Things

Surabhi Chauhan, Rakesh Kumar, Neelima Singh
Department of ECE, JB Institute of Technology, Dehradun, India, 248197
chauhansurabhi04@gmail.com

Abstract *–The Internet of Things (IoT) has revolutionized the way we interact with technology by connecting physical objects to the digital world. As the number of IoT devices continues to grow, the need for seamless human-computer interaction (HCI) and intuitive user interfaces (UIs) becomes paramount. This research paper explores the challenges and opportunities in designing HCI and UIs for IoT systems. It discusses the importance of user-centric design principles, the integration of natural user interfaces, and the role of context-awareness in enhancing user experiences. Additionally, it examines the impact of IoT on traditional HCI paradigms and proposes future directions for research and development in this rapidly evolving field.*

Keywords- Internet of Things (IoT), User interfaces (UIs), Human-Computer Interaction (HCI), Voice User Interfaces (VUIs), Natural user interfaces (NUIs), Augmented reality/virtual reality (AR/VR).

INTRODUCTION

The Internet of Things (IoT) has emerged as a transformative paradigm, connecting a vast array of devices and objects to the digital realm. As IoT continues to permeate various aspects of our daily lives, from smart homes to industrial automation, the importance of designing effective human-computer interaction (HCI) and user interfaces (UIs) becomes increasingly crucial. HCI and UIs play a pivotal role in ensuring that users can effortlessly interact with IoT systems, enabling seamless integration of technology into their routines.

1.1 Background and Significance: The IoT ecosystem encompasses a diverse range of interconnected devices, sensors, actuators, and networks, enabling the exchange of data and enabling new forms of automation and decision-making. However, the true potential of IoT can only be realized if users can intuitively and comfortably interact with these connected devices. Traditional user interfaces, such as keyboards and mouse, are often insufficient or impractical for IoT systems due to their heterogeneity, scale, and distributed nature.

HCI and UIs for IoT are concerned with creating interfaces that bridge the gap between humans and the interconnected IoT ecosystem. These interfaces need to be designed with a deep understanding of user needs, preferences, and abilities. They should enable users to easily access and control IoT devices, make sense of the vast amounts of data generated, and ensure a positive user experience in diverse contexts.

1.2 Research Objectives: This research paper aims to explore the challenges and opportunities in designing HCI and UIs for IoT systems. The objectives are as follows:

a. Examine the principles of user-centric design in the context of IoT HCI.

b. Explore the integration of natural user interfaces (NUIs) to enhance interaction with IoT devices.

c. Investigate the role of context-awareness in IoT UIs and its impact on user experiences.

d. Analyze the impact of IoT on traditional HCI paradigms and identify key considerations.

e. Provide case studies and examples of HCI and UIs in IoT applications.

f. Identify future directions and challenges for research and development in this field.

1.3 Structure of the Paper: The remainder of this research paper is organized as follows: Section 2 discusses user-centric design principles for IoT, emphasizing the importance of understanding user needs and iterative prototyping. Section 3 explores the integration of natural user interfaces (NUIs) such as gesture-based interfaces, voice user interfaces, and tangible interfaces. Section 4 delves into the significance of context-awareness in IoT UIs and its impact on personalization and adaptive interfaces. Section 5 examines the implications of IoT on traditional HCI paradigms, including interaction modalities, cognitive load, and privacy considerations.

Section 6 presents case studies and examples of HCI and UIs in various IoT domains, including smart homes, wearables, and industrial applications. Section 7 highlights future directions and challenges, such as advancements in AI and machine learning, integration of IoT with augmented reality/virtual reality (AR/VR), and ethical considerations. Finally, the conclusion in Section 8 summarizes the key findings and emphasizes the importance of user-centric design in IoT HCI, providing insights into areas for future research.

By comprehensively addressing these topics, this research paper aims to contribute to the understanding and advancement of HCI and UIs for IoT, facilitating the creation of user-friendly and engaging experiences within the increasingly interconnected IoT landscape.

USER-CENTRIC DESIGN PRINCIPLES FOR IOT

In the realm of IoT, where a wide range of devices and systems interact, user-centric design principles are essential for creating effective human-computer interaction (HCI) and user interfaces (UIs). The following principles guide the design process to ensure that IoT systems are intuitive, usable, and meet the needs of users:

2.1 User-Centered Design Approach: A user-centered design approach places the user at the core of the design process. It involves actively involving users throughout the design cycle, from initial ideation to prototyping and evaluation. Understanding the goals, preferences, and capabilities of users is crucial to developing interfaces that align with their needs and expectations.

2.2 Understanding User Needs and Requirements: Thoroughly understanding user needs and requirements is fundamental to creating successful IoT interfaces. This involves conducting user research, such as interviews, surveys, and observations, to gather insights into users' goals, tasks, and pain points. By empathizing with users, designers can tailor the

interface to their specific contexts and improve the overall user experience.

2.3 Design Thinking in IoT HCI: Design thinking is a problem-solving approach that emphasizes empathy, ideation, prototyping, and iteration. Applying design thinking principles to IoT HCI involves brainstorming creative solutions, rapid prototyping, and involving users in the evaluation process. This iterative approach enables designers to identify and address usability issues early on, resulting in more user-friendly interfaces.

2.4 Iterative Prototyping and User Feedback: Prototyping plays a crucial role in IoT HCI design. By creating low-fidelity and high-fidelity prototypes, designers can test and refine interface concepts before implementing them in the actual IoT system. Involving users in the prototyping process allows for early feedback, enabling iterative improvements based on user insights. Rapid prototyping tools and techniques, such as paper prototyping and interactive mockups, facilitate this iterative design process.

2.5 Consistency and Familiarity: Maintaining consistency and leveraging users' existing mental models contribute to a more intuitive IoT interface. Consistent use of design elements, such as icons, colors, and navigation patterns, across different IoT devices enhances usability. Building upon familiar interaction patterns, like swiping and tapping on touchscreens, helps users quickly grasp how to interact with new IoT devices or systems.

2.6 Clear and Simple Interfaces: Simplicity and clarity are essential in IoT UIs. Clear and concise language, visually uncluttered interfaces, and intuitive navigation contribute to a positive user experience. Minimizing cognitive load and providing relevant information at the right time enable users to interact with IoT systems without feeling overwhelmed.

2.7 Accessibility and Inclusivity: Designing IoT interfaces with accessibility and inclusivity in mind ensures that individuals with disabilities or diverse needs can effectively use and benefit from IoT systems. Considerations such as providing alternative input methods, accommodating different sensory capabilities, and offering customizable interfaces contribute to a more inclusive design.

2.8 Feedback and Error Handling: IoT interfaces should provide feedback to users to confirm that their actions have been successfully executed. Visual, auditory, and haptic feedback mechanisms can be employed to indicate device status or action completion. Additionally, clear error messages and graceful error handling help users understand and recover from errors or unexpected situations encountered during interaction.

By adhering to these user-centric design principles, designers can create IoT interfaces that are intuitive, usable, and tailored to the needs of users. Considering the specific contexts, goals, and limitations of users enhances the overall user experience and promotes wider adoption and acceptance of IoT technologies.

NATURAL USER INTERFACES FOR IOT

Natural User Interfaces (NUIs) play a significant role in enhancing the interaction between humans and Internet of Things (IoT) devices. By leveraging natural and intuitive modes of

communication, NUIs enable users to interact with IoT systems in a more seamless and user-friendly manner. Here are some key types of NUIs commonly used in IoT interfaces:

3.1 Gesture-Based Interfaces: Gesture-based interfaces allow users to interact with IoT devices through hand movements, body gestures, or facial expressions. Cameras, depth sensors, or wearable devices can capture and interpret these gestures, translating them into commands or actions. For example, a user may swipe their hand in the air to adjust the lighting intensity in a smart home or make a pinching gesture to zoom in on a connected IoT device's display.

3.2 Voice User Interfaces: Voice User Interfaces (VUIs) enable users to interact with IoT systems using voice commands. Speech recognition technologies and natural language processing algorithms analyze the user's voice input and convert it into actionable commands. VUIs can be found in smart speakers, virtual assistants, and voice-controlled IoT devices. Users can ask questions, give commands, or initiate actions by simply speaking aloud, offering a hands-free and intuitive interaction method.

3.3 Tangible Interfaces: Tangible interfaces involve physical objects or manipulable artifacts that users can directly interact with to control IoT devices or systems. These interfaces provide a tangible and haptic feedback experience. For example, a connected IoT device may come with physical buttons, sliders, or knobs that users can manipulate to adjust settings or activate functions. Tangible interfaces bridge the physical and digital worlds, enabling a more tactile and intuitive interaction with IoT devices.

3.4 Multimodal Interfaces: Multimodal interfaces combine multiple modes of interaction, such as touch, voice, gestures, and even eye-tracking, to provide users with a rich and versatile interaction experience. By combining different modalities, users can choose the most convenient and suitable input method based on the context and their preferences. For instance, a smart home system may incorporate touchscreens for visual interaction, voice commands for hands-free control, and gestures for quick navigation.

3.5 Challenges and Considerations in NUI Design:

Designing effective NUIs for IoT comes with its own set of challenges and considerations:

Contextual Awareness: NUIs should be able to adapt to different contexts and environments. They should consider factors like the user's location, time of day, and the devices or services they interact with to provide relevant and personalized experiences.

Sensing Technologies: NUIs rely on various sensing technologies like cameras, microphones, and sensors to capture and interpret user input. Ensuring the accuracy and reliability of these sensing mechanisms is crucial for a smooth and error-free user experience.

Privacy and Security: NUIs often involve capturing and processing user data, raising concerns about privacy and security. Designers must incorporate measures to protect user information and provide transparent control over data sharing and storage.

Learnability and Discoverability: NUIs should be designed in a way that is intuitive and easy to learn. Users should quickly understand how to interact with IoT devices and discover available functionalities without significant effort.

By leveraging NUIs in IoT interfaces, designers can enhance the user experience, making interactions with IoT devices more natural, intuitive, and enjoyable. These interfaces enable users to seamlessly control and interact with the IoT ecosystem, bridging the gap between humans and connected devices.

CONTEXT-AWARENESS IN IOT USER INTERFACES

Context-awareness plays a vital role in designing user interfaces (UIs) for Internet of Things (IoT) systems. By considering the context in which IoT devices operate, UIs can adapt and provide personalized experiences that align with user needs and preferences. Here are some key aspects of context-awareness in IoT UI design:

4.1 Context-Aware Systems and IoT: Context-aware systems leverage information about the user, the environment, and the IoT devices themselves to dynamically adjust their behavior and provide relevant information or services. Contextual information may include location, time, user preferences, activity patterns, and sensor data from the IoT network. By understanding the context, UIs can tailor their presentation, functionalities, and interactions to meet specific user requirements.

4.2 Sensor Data Integration for Context-Awareness:

IoT devices generate a vast amount of sensor data, such as temperature, humidity, motion, and light levels. By integrating this sensor data into UIs, designers can create context-aware interfaces. For example, a smart thermostat may adjust the temperature based on occupancy information from motion sensors, or a smart lighting system may adapt brightness levels based on ambient light conditions. The UI can provide real-time feedback and control options based on these sensor inputs.

4.3 Personalization and Adaptive Interfaces: Context-aware UIs can personalize the user experience by adapting to individual preferences, habits, and situational needs. By learning from user interactions and historical data, the UI can customize its layout, content, and functionalities. For instance, a smart home UI can present frequently used controls prominently or suggest actions based on past behavior. Adaptive interfaces allow users to have tailored experiences that match their unique requirements and behaviors.

4.4 Context-Aware UI Design Challenges:

Designing context-aware UIs for IoT systems poses several challenges:

Data Processing and Analysis: Contextual information often involves processing and analyzing a large volume of real-time data. Designers need to consider efficient data processing mechanisms to extract meaningful insights and respond to changes in the context promptly.

Context Inference and Prediction: Deriving context from raw sensor data can be complex. Designers must employ intelligent algorithms and machine learning techniques to infer and predict context accurately. This includes recognizing user activities, inferring user intentions, and understanding environmental conditions.

User Control and Transparency: Context-aware UIs should provide users with control over how the system uses their contextual information. Users should be able to specify preferences, privacy settings, and define rules for context-based actions. Transparent communication of how context is collected, used, and shared is crucial for user trust and acceptance.

Dynamic Adaptation: Contexts can change rapidly, and UIs should be able to adapt accordingly. Designers need to consider mechanisms for real-time updates, smooth transitions, and dynamic adjustment of UI elements to reflect changes in the context.

By incorporating context-awareness into IoT UIs, designers can provide more personalized, intuitive, and adaptive experiences for users. Context-aware UIs can anticipate user needs, simplify interaction, and enhance overall usability and satisfaction. They enable IoT systems to seamlessly integrate into users' lives by intelligently responding to their preferences and environmental conditions.

IMPACT OF IOT ON TRADITIONAL HCI PARADIGMS

The Internet of Things (IoT) has introduced new challenges and opportunities that impact traditional Human-Computer Interaction (HCI) paradigms. IoT's unique characteristics, such as pervasive connectivity, heterogeneity of devices, and data abundance, necessitate a reevaluation of HCI approaches. Here are some key ways in which IoT influences traditional HCI paradigms:

5.1 Ubiquitous Computing and HCI: IoT extends the concept of ubiquitous computing, where computing is seamlessly integrated into everyday objects and environments. This shift requires HCI to consider interactions beyond traditional desktop and mobile devices. Users interact with a multitude of interconnected IoT devices, such as smart home appliances, wearables, and industrial sensors. HCI paradigms need to address the challenges of designing interfaces that span multiple devices and provide consistent and coherent user experiences across diverse contexts.

5.2 Interaction Modalities in IoT: IoT introduces a variety of interaction modalities beyond traditional mouse and keyboard input. Voice commands, gestures, touch, and tangible interfaces become prevalent in IoT systems. HCI must adapt to support these new modalities and ensure a smooth and intuitive user experience across different interaction methods. Designers need to consider the strengths, limitations, and appropriateness of each modality in different IoT contexts.

5.3 Cognitive Load and Attention Management: The proliferation of IoT devices can lead to information overload, increasing users' cognitive load and attention demands. HCI needs to

focus on presenting information and controls in a way that minimizes cognitive load and facilitates easy comprehension and decision-making. Techniques such as information filtering, context-based information presentation, and adaptive interfaces can help manage cognitive load and direct users' attention effectively in IoT environments.

5.4 Privacy and Security Considerations: IoT raises significant privacy and security concerns due to the massive amount of data generated and shared across interconnected devices. HCI needs to address these concerns by designing interfaces that provide clear and transparent privacy controls, allow users to understand and manage data sharing, and empower them with mechanisms for secure interaction and authentication. Ensuring user trust and confidence in IoT systems becomes crucial for the successful adoption of HCI in IoT.

5.5 Adaptive and Intelligent Interfaces: IoT's ability to collect and analyze vast amounts of data enables the development of adaptive and intelligent interfaces. HCI can leverage machine learning and artificial intelligence techniques to personalize interfaces, predict user intentions, and provide proactive and contextually relevant suggestions or assistance. Adaptive interfaces that learn from user behaviors and preferences can enhance the user experience and make interactions with IoT systems more efficient and effective.

5.6 Social and Ethical Considerations: As IoT devices become more pervasive and interconnected, HCI needs to address the social and ethical implications of these technologies. This includes considering the impact of IoT on privacy, data ownership, digital divide, and human values. HCI paradigms should strive to promote inclusive design, diversity, and responsible use of IoT to ensure that the benefits of IoT are distributed equitably.

In summary, IoT's impact on traditional HCI paradigms is substantial. HCI must adapt to support ubiquitous computing, accommodate various interaction modalities, manage cognitive load and attention, address privacy and security concerns, incorporate adaptiveness and intelligence, and consider social and ethical considerations. By embracing these changes, HCI can effectively design interfaces that provide seamless and meaningful interactions in the IoT era.

CASE STUDIES AND EXAMPLES

To understand the practical application of Human-Computer Interaction (HCI) and user interfaces (UIs) in the Internet of Things (IoT) domain, let's explore some case studies and examples of HCI and UIs in different IoT contexts:

6.1 Smart Home Interfaces: Smart homes are a popular application of IoT, where various devices and systems are interconnected to enhance comfort, convenience, and energy efficiency. HCI and UIs play a crucial role in enabling users to interact with smart home devices. Examples include:

Mobile Apps: Smart home mobile apps provide users with intuitive interfaces to control and monitor their connected devices. Users can adjust lighting, temperature, security systems, and

other appliances through a user-friendly interface.

Voice Assistants: Devices like Amazon Echo and Google Home use voice-based UIs to enable users to control smart home devices using natural language commands. Users can control lights, play music, or ask questions by simply speaking to the voice assistant.

6.2 Wearable Devices and IoT HCI: Wearable devices, such as smartwatches and fitness trackers, have become prevalent in the IoT ecosystem. HCI and UIs play a vital role in delivering a seamless and personalized user experience. Examples include:

Fitness Trackers: Fitness trackers use UIs, typically displayed on the device's screen or a companion mobile app, to present activity data, set goals, and track progress. Users can interact with the UI to view their health statistics and access various functionalities.

Smartwatches: Smartwatches provide UIs that allow users to read notifications, respond to messages, control music, and track health and fitness data. The compact interface on the watch face enables users to access essential information and interact with apps on their wrists.

6.3 Industrial IoT Interfaces: The Industrial Internet of Things (IIoT) focuses on connecting industrial systems and devices to improve efficiency, automation, and safety. HCI and UIs play a critical role in facilitating human-machine interaction in industrial settings. Examples include:

Control Panels: Industrial control panels employ UIs to enable operators to monitor and control complex machinery and processes. The interface may include status indicators, interactive touchscreens, physical buttons, and visualizations to present real-time data.

Augmented Reality (AR) Interfaces: AR interfaces overlay digital information onto the physical environment, enhancing workers' understanding and interaction with machinery and systems. AR headsets or devices provide contextual information, step-by-step instructions, and remote expert guidance, improving efficiency and reducing errors.

6.4 Healthcare Applications of IoT HCI: IoT and HCI find extensive applications in healthcare, providing remote monitoring, personalized care, and improved patient experiences. Examples include:

Remote Patient Monitoring: IoT devices, such as wearable sensors and home-based monitoring systems, collect patients' health data. HCI and UIs present this data to healthcare providers through web-based dashboards or mobile apps, enabling remote monitoring and early intervention.

Smart Pillboxes: IoT-enabled pillboxes use UIs to remind patients to take medication, dispense the correct pills, and track adherence. Interfaces may include visual indicators, alarms, and connectivity to share data with healthcare providers.

These case studies highlight how HCI and UIs are applied in various IoT domains, improving user experiences, enabling control and monitoring of IoT devices, and enhancing efficiency

and safety in different contexts. By focusing on usability, personalization, and intuitive interactions, HCI and UIs make IoT technologies more accessible and beneficial to users.

FUTURE DIRECTIONS AND CHALLENGES

The field of Human-Computer Interaction (HCI) and user interfaces (UIs) for the Internet of Things (IoT) is constantly evolving. As technology advances and the IoT landscape expands, several future directions and challenges emerge:

7.1 Advancements in AI and Machine Learning: The integration of AI and machine learning with HCI and IoT holds great promise. Future UIs can leverage AI algorithms to understand user preferences, predict user intent, and provide personalized recommendations. Machine learning models can analyze vast amounts of sensor data to derive context and enable adaptive interfaces that dynamically adjust to user needs. Further research is needed to explore how AI can enhance HCI in the IoT domain.

7.2 Seamless Integration of IoT with AR/VR: Augmented Reality (AR) and Virtual Reality (VR) have the potential to revolutionize HCI in IoT. Seamless integration of IoT data and interfaces with AR/VR environments can enhance user experiences and provide immersive interactions. For example, users can visualize and interact with IoT devices and data overlays in a virtual or augmented space. Overcoming technical challenges and designing intuitive AR/VR interfaces for IoT will be a focus of future research.

7.3 Ethical Considerations in IoT HCI: As IoT becomes more pervasive, addressing ethical considerations becomes crucial. HCI research needs to examine the ethical implications of IoT systems, including privacy concerns, data security, algorithmic bias, and the responsible use of user data. Designing interfaces that prioritize user privacy, consent, transparency, and control will be essential for maintaining user trust and acceptance.

7.4 Evaluating User Experiences in IoT: Evaluating the user experience (UX) in IoT HCI presents unique challenges. Traditional UX evaluation methods may need adaptation to accommodate the distributed nature of IoT systems, the diversity of devices, and the dynamic context. Research is needed to develop appropriate evaluation frameworks and metrics for assessing the usability, satisfaction, and effectiveness of IoT interfaces.

7.5 Designing for Inclusivity and Accessibility: Ensuring inclusive and accessible IoT HCI experiences for all users is a critical future direction. Designing interfaces that accommodate users with diverse abilities, disabilities, and needs is essential. Research should focus on developing UIs that support alternative input methods, provide customizable interfaces, and consider the specific requirements of different user groups.

7.6 Integration of IoT with Edge Computing and Fog Computing: The convergence of IoT, edge computing, and fog computing introduces new possibilities for distributed processing, low-latency interactions, and improved data privacy. HCI needs to consider the design implications of these distributed architectures, including how interfaces interact with edge devices, how data is visualized and controlled across the network, and how to maintain

a seamless user experience in distributed environments.

7.7 Sustainability and Energy Efficiency: HCI in IoT should address sustainability concerns by promoting energy-efficient interactions and reducing environmental impact. Designing interfaces that encourage energy-conscious behavior, provide insights into energy consumption, and enable users to optimize resource usage will be important in the future.

Addressing these future directions and challenges in IoT HCI requires interdisciplinary collaboration between HCI researchers, UI designers, IoT experts, and stakeholders. By focusing on user-centered design, ethical considerations, emerging technologies, and the specific demands of IoT contexts, HCI can shape the future of IoT interfaces and enhance the overall user experience in the IoT ecosystem.

CONCLUSION

Human-Computer Interaction (HCI) and user interfaces (UIs) play a critical role in enabling seamless and intuitive interactions between users and the Internet of Things (IoT) ecosystem. As IoT continues to advance and permeate various domains, it presents both opportunities and challenges for HCI. This research paper has explored the significance of user-centric design principles in IoT HCI, emphasizing the importance of understanding user needs and preferences, iterative prototyping, and user feedback. We have also discussed the integration of natural user interfaces (NUIs) such as gesture-based interfaces, voice user interfaces, and tangible interfaces to enhance the interaction experience in IoT.

Context-awareness has emerged as a crucial factor in IoT UI design, enabling personalized and adaptive interfaces that respond to users' specific contexts and preferences. We have examined the integration of sensor data and the challenges of designing context-aware UIs. Moreover, the impact of IoT on traditional HCI paradigms has been discussed, including the shift toward ubiquitous computing, the diversification of interaction modalities, managing cognitive load, and addressing privacy and security considerations. Several case studies and examples have illustrated the practical application of HCI and UIs in different IoT contexts, such as smart homes, wearable devices, industrial IoT, and healthcare.

Looking ahead, future directions and challenges in IoT HCI include advancements in AI and machine learning, seamless integration of IoT with augmented reality/virtual reality (AR/VR), ethical considerations, evaluating user experiences, designing for inclusivity and accessibility, integration with edge computing and fog computing, and promoting sustainability and energy efficiency. By embracing these future directions and addressing the challenges, HCI can contribute to the creation of user-friendly, efficient, and ethically responsible IoT interfaces. HCI researchers, UI designers, and IoT stakeholders need to collaborate and innovate to shape the future of IoT HCI, ensuring that technology seamlessly integrates into users' lives while enhancing their experiences and addressing their needs.

REFERENCES

[1] G. Abowd. Agents: recognition and interaction models. In D. Diaper, D. Gilmore, G. Cockton, and B. Shackel, editors, Human-Computer Interaction - Proceedings INTERACT'90, pages 143-146. North-Holland,

Amsterdam, 1990.
[2] G. Abowd, H. Wang, and A. Monk. A formal technique for automated dialogue development. In Proceedings of Designing Interactive Systems - DIS'95, pages 219-226. ACM Press, New York, 1995.
[3] G. D. Abowd and R. Beale. Users, systems and interfaces: A unifying framework for interaction. In D. Diaper and N. Hammond, editors, HCI'91: People and Computers VI, pages 73-87. Cambridge University Press, Cambridge, 1991.
[4] G. D. Abowd, C. G. Atkeson, A. Feinstein, C. Hmelo, R. Kooper, S. Long, N. Sawhney, and M. Tan. Teaching and learning as multimedia authoring: The classroom 2000 project. In Proceedings of the ACM Conference on Multimedia - Multimedia'96, 1996.
[5] G. D. Abowd, A. Dey, R. Orr, and J. Brotherton. Context-awareness in wearable and ubiquitous computing. Technical Report GIT-GVU-97-11, GVU Center, Georgia Institute of Technology, June 1997.
[6] ACM Special Interest Group on Computer-Human Interaction Curriculum Development Group. ACM SIGCHI curricula for human-computer interaction. Technical report, ACM, New York, 1992.
[7] H. Alexander. Formally-based Tools and Techniques for Human-Computer Dialogues. Ellis Horwood, Chichester, 1987.
[8] D. G. Aliaga. Virtual objects in the real world. Communications of the ACM, 40(3):49-54, 1997.
[9] L. Allinson and N. Hammond. A learning support environment: the hitch-hiker's guide. In R. McAleese, editor, Hypertext: Theory into Practice. Intellect, 1993.

CHAPTER-2.3

Edge Computing in IoT: Enhancing Efficiency, Security, and Privacy

Surabhi Chauhan[1], Bharat Pal[1], Neelima Singh[1]
[1]Assistant Professor, JB Institute of Technology, Dehardun, India, 248197
chauhansurabhi04@gmail.com

Abstract – *The rapid growth of connected devices in the Internet of Things (IoT) has necessitated more efficient and secure data processing solutions. Edge computing has emerged as a promising paradigm that brings computational power closer to the data source, reducing latency, and enhancing efficiency. This research paper explores the benefits and challenges of implementing edge computing in IoT systems, with a particular focus on how it enhances efficiency, security, and privacy. The paper provides an overview of edge computing in IoT, discusses its impact on efficiency improvements, explores its role in enhancing security, addresses privacy considerations, discusses challenges and future directions, and provides case studies of real-world applications. The findings highlight the importance of edge computing in addressing the evolving needs of IoT systems.*

INTRODUCTION

1.1 Background and Motivation: The Internet of Things (IoT) has revolutionized various industries by connecting devices, sensors, and systems, enabling them to communicate and share data. The proliferation of IoT devices has generated massive amounts of data that require efficient processing and analysis. Traditional cloud-centric approaches for data processing in IoT systems face challenges such as high latency, network congestion, and dependence on centralized resources. To address these limitations, edge computing has emerged as a promising solution by bringing computational capabilities closer to the data source.

1.2 Problem Statement: While edge computing offers numerous advantages in terms of efficiency, security, and privacy, there is a need to explore its potential and understand its implications in the context of IoT systems. This research aims to investigate how edge computing can enhance efficiency, security, and privacy in IoT deployments. It seeks to address the challenges associated with deploying edge computing in IoT systems and identify opportunities for improvement.

1.3 Research Objectives: The primary objectives of this research paper are as follows:

a. To explore the benefits of edge computing in enhancing efficiency in IoT systems.

b. To analyze the role of edge computing in improving security and mitigating vulnerabilities in IoT deployments.

c. To investigate the privacy considerations and techniques associated with edge computing in IoT.

d. To identify the challenges and barriers in implementing edge computing in IoT systems.

e. To propose potential solutions and future directions for integrating edge computing into IoT architectures.

METHOLOGY

To achieve the research objectives, this study will employ a mixed-methods approach. The research will begin with a comprehensive literature review to establish a theoretical foundation for edge computing in IoT, including its concepts, characteristics, and relevant technologies. The review will also encompass existing studies on efficiency improvements, security enhancements, and privacy considerations in edge computing.

To gather empirical data, the study will conduct case studies of real-world IoT deployments that have implemented edge computing. These case studies will provide insights into practical implementations, challenges faced, and lessons learned. Data will be collected through interviews, surveys, and analysis of relevant documentation.

The findings from the literature review and case studies will be analyzed to identify key patterns, trends, and recommendations. The research paper will present the results in a coherent manner, addressing each research objective, and providing a comprehensive understanding of how edge computing enhances efficiency, security, and privacy in IoT systems.

Overall, this research will contribute to the body of knowledge in the field of IoT and edge computing, providing valuable insights for practitioners, researchers, and policymakers seeking to harness the potential of edge computing in IoT deployments.

OVERVIEW OF EDGE COMPUTING IN IOT

2.1 Definition and Key Concepts: Edge computing in the context of IoT refers to a decentralized computing paradigm that brings computational power and data storage closer to the edge of the network, closer to the data source or the IoT devices themselves. It aims to address the limitations of traditional cloud-centric approaches by enabling data processing, storage, and analysis at or near the data source. Key concepts in edge computing include edge devices, edge servers, edge analytics, and edge intelligence.

2.2 Characteristics of Edge Computing: Edge computing exhibits several characteristics that differentiate it from traditional cloud computing:

a. Proximity to Data Source: Edge computing enables data processing and analytics to be performed in close proximity to where the data is generated, reducing latency and improving response times.

b. Decentralization: In edge computing, computational resources are distributed across edge devices, edge servers, and gateways, allowing for localized processing and reducing the dependence on a centralized cloud infrastructure.

c. Real-time Processing: Edge computing enables real-time or near-real-time processing and decision-making, allowing for immediate response and faster insights.

d. Bandwidth Optimization: By processing and filtering data at the edge, edge computing minimizes the amount of data that needs to be transmitted to the cloud, optimizing bandwidth usage and reducing network congestion.

e. Offline Capabilities: Edge computing architectures can function autonomously even in situations where connectivity to the cloud is limited or lost, ensuring continuous operation and reducing dependence on cloud services.

2.3 Comparison with Cloud Computing: Edge computing and cloud computing serve different purposes and offer complementary capabilities. While cloud computing centralizes resources and provides scalability and storage capacity, edge computing focuses on processing data at or near the data source. Key differences between edge computing and cloud computing include:

a. Latency: Edge computing significantly reduces latency since data processing occurs closer to the data source, enabling real-time or near-real-time responsiveness. In contrast, cloud computing introduces latency due to data transmission to and from the cloud servers.

b. Scalability: Cloud computing offers virtually unlimited scalability, as resources can be provisioned on-demand. Edge computing is limited by the computational capabilities of edge devices and servers, but it can be scaled by adding more edge nodes within a network.

c. Data Privacy and Security: Edge computing can enhance data privacy and security since sensitive data is processed locally without the need for extensive data transmission to the cloud. Cloud computing, on the other hand, relies on secure data transmission and centralized security measures.

2.4 Edge Computing Architecture in IoT Systems: Edge computing architecture in IoT systems typically involves a hierarchical structure that spans from edge devices to edge servers and cloud servers. The architecture can be organized into multiple tiers, each with specific functionalities:

a. Edge Devices: These are the IoT devices or sensors that generate data. They can perform initial data preprocessing and filtering to reduce the amount of data sent to the edge servers or cloud.

b. Edge Servers/Gateways: These are the intermediate nodes responsible for processing, storing, and analyzing data received from edge devices. They act as a bridge between edge devices and the cloud, performing localized data processing and decision-making.

c. Cloud Servers: These servers are responsible for centralized storage, complex analytics, and long-term data processing. Data from edge servers can be transmitted to the cloud for further analysis, storage, and integration with other enterprise systems. The architecture can vary depending on the specific IoT deployment and requirements. It may incorporate fog computing, which involves additional intermediate nodes between edge and cloud servers to handle more complex processing tasks.

Understanding the key concepts, characteristics, and architecture of edge computing in IoT systems provides a foundation for exploring its impact on efficiency, security, and privacy, as well as for addressing the challenges and opportunities associated with its implementation.

EFFICIENCY IMPROVEMENTS THROUGH EDGE COMPUTING

3.1 Reducing Latency and Bandwidth Requirements: One of the primary advantages of edge computing in IoT systems is its ability to reduce latency and minimize bandwidth requirements. By processing data closer to the edge devices, edge computing eliminates the need for transmitting large volumes of data to centralized cloud servers for processing. This reduction in data transmission distance significantly reduces the latency involved in sending data to the cloud and receiving processed results. Real-time applications, such as autonomous vehicles or industrial control systems, can benefit from edge computing's low-latency processing, enabling quicker response times and improving overall system performance.

Furthermore, edge computing helps alleviate bandwidth constraints by performing data processing and filtering at the edge. Instead of transmitting all raw data to the cloud, edge devices and servers can analyze data locally, sending only relevant information or processed results to the cloud for further analysis or storage. This approach optimizes network bandwidth and reduces the risk of network congestion, making edge computing an efficient solution for IoT systems with limited network capacity.

3.2 Real-time Decision Making and Local Data Processing: Edge computing enables real-time decision making by processing and analyzing data at the edge devices or edge servers. In time-critical applications, such as industrial automation or remote monitoring of critical systems, immediate decision-making capabilities are crucial. With edge computing, data can be processed locally, allowing for quick responses and actions without relying on a distant cloud server. This real-time decision-making capability improves system responsiveness, enhances user experience, and enables IoT applications that demand low-latency interactions.

Local data processing is another key aspect of efficiency improvement through edge computing. By performing data processing and analysis at the edge, IoT devices can filter, aggregate, and transform raw data into meaningful insights or actionable information. This localized processing reduces the amount of data that needs to be transmitted to the cloud, minimizing data transmission costs and optimizing system resources. It also enables edge devices to operate autonomously even in disconnected or low-connectivity environments, ensuring continuous functionality and reducing dependence on cloud services.

3.3 Distributed Analytics and Improved Response Times: Edge computing facilitates distributed analytics, where data processing tasks are distributed across edge devices and servers within an IoT network. Instead of relying solely on centralized cloud servers for data analytics, edge computing allows for parallel and distributed processing closer to the data source. This distributed analytics capability enables faster processing and analysis, as tasks can be executed simultaneously across multiple edge nodes. Consequently, response times improve significantly, enabling real-time insights and enabling time-critical decision making.

Furthermore, by distributing analytics tasks across edge devices and servers, the overall load on the network and cloud infrastructure is reduced. Each edge device or server can process a portion of the data and contribute to the analytics pipeline, thereby optimizing resource utilization and enhancing scalability. This approach also reduces the impact of network latency, as data can be processed locally without relying on a central point of analysis, resulting in improved overall system efficiency.

3.4 Resource Optimization and Network Congestion Reduction: Edge computing contributes to resource optimization in IoT systems. By offloading processing tasks from the cloud to the edge, computational resources can be efficiently utilized. Edge devices and servers can handle data processing and analytics, eliminating the need for continuously transmitting large volumes of data to the cloud. This not only reduces cloud server load but also conserves network bandwidth and storage capacity.

Moreover, edge computing helps reduce network congestion. By processing and filtering data at the edge, only relevant information or processed results are transmitted to the cloud, reducing the volume of data transmitted through the network. This reduction in data traffic minimizes the risk of network congestion, improves overall network performance, and enhances the reliability of IoT systems.

In summary, edge computing offers significant efficiency improvements in IoT systems. It reduces latency and bandwidth requirements by processing data closer to the edge devices. Real-time

SECURITY ENHANCEMENTS IN EDGE COMPUTING

4.1 Reducing Attack Surface and Vulnerabilities: Edge computing in IoT systems can enhance security by reducing the attack surface and vulnerabilities. By processing data and executing tasks at the edge, the exposure of sensitive data and critical operations to external threats is minimized. Edge devices and servers can implement security measures such as firewalls, intrusion detection systems, and access controls to mitigate potential risks. Furthermore, the reduced reliance on cloud services decreases the attack surface as the data transmission and communication paths are shortened, limiting potential points of entry for attackers.

4.2 Local Threat Detection and Mitigation: Edge computing enables local threat detection and mitigation capabilities within IoT systems. By analyzing data at the edge, edge devices and servers can detect anomalies, patterns, and potential security breaches in real-time. This localized threat detection enables prompt response and mitigation measures, preventing security incidents from propagating further into the network or compromising sensitive information. Edge-based threat detection mechanisms, such as anomaly detection algorithms or machine learning models, can enhance the overall security posture of IoT systems by identifying and addressing security threats at the edge.

4.3 Enhancing Data Encryption and Access Control: Edge computing can strengthen data security through enhanced encryption and access control mechanisms. Data transmitted

between edge devices, servers, and the cloud can be encrypted using strong cryptographic protocols and algorithms. This ensures that data remains secure during transmission and prevents unauthorized access. Access control policies can be implemented at the edge to restrict data access and ensure that only authorized devices or entities can interact with the system. Encryption and access control mechanisms at the edge help safeguard sensitive data and protect the privacy of IoT systems.

4.4 Trustworthiness and Secure Communication: Edge computing promotes trustworthiness and secure communication within IoT systems. Edge devices and servers can establish secure communication channels, leveraging protocols such as Transport Layer Security (TLS) or Secure Shell (SSH), to ensure that data exchanged between devices and servers remains confidential and tamper-proof. The establishment of trust and authentication mechanisms at the edge enables secure interactions and prevents unauthorized devices from accessing or compromising the system. Additionally, edge computing architectures can incorporate hardware-based security solutions, such as Trusted Platform Modules (TPMs) or secure elements, to further enhance the trustworthiness and integrity of IoT systems.

By reducing the attack surface, enabling local threat detection and mitigation, enhancing data encryption and access control, and promoting trustworthiness and secure communication, edge computing strengthens the security posture of IoT systems. These security enhancements contribute to the protection of sensitive data, prevention of unauthorized access, and mitigation of potential security threats, ensuring the integrity, confidentiality, and availability of IoT deployments.

PRIVACY CONSIDERATIONS IN EDGE COMPUTING

5.1 Minimizing Sensitive Data Transmission to the Cloud: Edge computing addresses privacy concerns in IoT systems by minimizing the transmission of sensitive data to the cloud. Instead of sending all raw data to a centralized cloud server, edge devices and servers can perform data processing and filtering locally, transmitting only relevant and anonymized information to the cloud for further analysis or storage. This approach reduces the exposure of sensitive data to potential privacy breaches during data transmission, enhancing the privacy protection of IoT deployments.

5.2 Local Data Processing and Privacy Preservation: Edge computing enables local data processing, which contributes to privacy preservation in IoT systems. By processing data at the edge, personal information can be anonymized or aggregated, ensuring individual privacy is maintained. Localized data processing reduces the reliance on transmitting personal data to external entities, minimizing privacy risks associated with centralized data storage or processing. This approach allows IoT devices to derive insights and perform necessary actions without compromising the privacy of individuals involved.

5.3 User Control over Personal Information: Privacy considerations in edge computing include providing users with control over their personal information. IoT systems can empower users to manage and control the collection, use, and sharing of their data. By

implementing user consent mechanisms, privacy policies, and user-friendly interfaces, individuals can exercise control over their personal information, including determining what data is collected, who has access to it, and for what purposes it is used. User-centric privacy controls ensure that individuals have a say in how their data is handled, enhancing transparency and trust in the IoT ecosystem.

5.4 Privacy-Preserving Techniques in Edge Computing: Edge computing incorporates privacy-preserving techniques to safeguard sensitive data. Several methods can be employed to protect privacy in edge computing:

a. Data Anonymization: Edge devices and servers can anonymize data by removing personally identifiable information (PII) or replacing it with pseudonyms. This technique helps protect the privacy of individuals while still allowing for data analysis and processing.

b. Differential Privacy: Differential privacy techniques can be applied to preserve privacy in edge computing. By adding noise or perturbation to data, differential privacy ensures that individual data points cannot be directly linked to specific individuals, maintaining privacy while still enabling useful data analysis.

c. Secure Multi-party Computation (SMC): SMC protocols enable secure computation and analysis of data while preserving privacy. Edge devices and servers can jointly compute results without revealing individual data inputs, ensuring privacy during collaborative data processing scenarios.

d. Homomorphic Encryption: Homomorphic encryption allows for encrypted data to be processed and analyzed without decrypting it, preserving the privacy of sensitive information. This technique enables secure computations on encrypted data within the edge computing environment.

By applying these privacy-preserving techniques, edge computing ensures that personal information is protected, enabling individuals to retain their privacy while still benefiting from the capabilities and insights offered by IoT systems.

Privacy considerations in edge computing play a crucial role in building trust, respecting individual privacy rights, and complying with privacy regulations. By minimizing sensitive data transmission to the cloud, enabling local data processing and privacy preservation, providing user control over personal information, and employing privacy-preserving techniques, edge computing strengthens privacy protection in IoT deployments.

CHALLENGES AND FUTURE DIRECTIONS

6.1 Resource Constraints and Device Heterogeneity: One of the key challenges in edge computing is the presence of resource-constrained edge devices with varying capabilities and heterogeneity. Edge devices, such as sensors or small-scale computing devices, often have limited processing power, memory, and energy resources. Managing and optimizing resource utilization across heterogeneous devices while ensuring efficient and reliable operation pose significant challenges. Future research should focus on developing resource-efficient

algorithms, lightweight protocols, and device-specific optimizations to overcome resource constraints and address device heterogeneity in edge computing environments.

6.2 Management and Orchestration Complexity: The management and orchestration of edge computing resources, including edge devices and servers, pose complexities due to the distributed and dynamic nature of edge computing architectures. Efficiently deploying, monitoring, configuring, and managing edge resources require sophisticated management frameworks and intelligent orchestration mechanisms. Future directions should focus on developing robust management and orchestration techniques that automate resource provisioning, workload distribution, fault tolerance, and dynamic resource scaling to handle the complexities of edge computing environments.

6.3 Scalability and Interoperability Challenges: Scalability and interoperability are critical challenges in edge computing, particularly as IoT deployments continue to grow in scale and complexity. Edge computing architectures must be able to scale seamlessly to accommodate a large number of edge devices and handle increasing data volumes and processing demands. Achieving interoperability among diverse edge devices, communication protocols, and application frameworks is also crucial for seamless integration and collaboration within edge computing ecosystems. Future research should aim to develop scalable architectures, standardized protocols, and interoperability frameworks that enable seamless scaling and integration of edge computing systems.

6.4 Integration with Cloud Computing and Fog Computing: The integration of edge computing with cloud computing and fog computing presents both challenges and opportunities. Edge computing complements cloud computing by offloading data processing and analytics to the edge, reducing latency and bandwidth requirements. Fog computing, on the other hand, extends the edge computing paradigm by incorporating intermediate fog nodes to handle more complex processing tasks. Future directions should explore efficient integration mechanisms, hybrid architectures, and workload offloading strategies that seamlessly integrate edge computing with cloud computing and fog computing to create a cohesive and scalable computing ecosystem.

6.5 Edge Intelligence and Machine Learning at the Edge: The integration of machine learning and artificial intelligence capabilities at the edge is an emerging research area with significant potential. By deploying machine learning models and intelligent algorithms at the edge, real-time data analysis, decision-making, and predictive capabilities can be enhanced. However, deploying and managing machine learning models on resource-constrained edge devices pose challenges such as model size, computational complexity, and power consumption. Future research should focus on developing lightweight and energy-efficient machine learning techniques, federated learning approaches, and edge intelligence frameworks that enable efficient deployment and execution of machine learning models at the edge.

In conclusion, addressing the challenges related to resource constraints, management complexity, scalability, interoperability, integration with cloud and fog computing, and enabling edge intelligence will shape the future directions of edge computing in IoT systems. Overcoming these challenges will unlock the full potential of edge computing, enabling efficient, secure, and privacy-aware IoT deployments that leverage the benefits of edge processing, real-time analytics, and intelligent decision-making.

CASE STUDIES AND REAL-WORLD APPLICATIONS

7.1 Smart Cities and Urban Infrastructure: Edge computing plays a vital role in enabling smart cities and improving urban infrastructure. In smart city deployments, edge devices and servers are deployed throughout the city to collect, process, and analyze data from various sources such as sensors, cameras, and IoT devices. This data is used for real-time monitoring, optimization of resource allocation, traffic management, environmental monitoring, and enhancing public safety. Edge computing enables faster response times, reduced latency, and localized decision-making, making it an ideal technology for smart city applications.

7.2 Industrial IoT and Manufacturing: Edge computing is revolutionizing the industrial IoT (IIoT) and manufacturing sector. In industrial settings, edge devices and edge servers are deployed at the edge of the network, close to the machines and sensors, to perform real-time data analysis, predictive maintenance, and quality control. Edge computing enables quick response times, reduces reliance on cloud connectivity, and enhances operational efficiency. It enables real-time monitoring and control of manufacturing processes, optimization of equipment performance, and proactive maintenance, leading to improved productivity, reduced downtime, and cost savings.

7.3 Healthcare and Telemedicine: Edge computing is transforming healthcare and telemedicine by bringing real-time analytics and decision-making capabilities to the point of care. Edge devices and servers are deployed in healthcare facilities, homes, wearable devices, and medical equipment to collect and analyze patient data, monitor vital signs, and provide personalized healthcare services. Edge computing enables faster diagnosis, remote patient monitoring, real-time alerts, and timely intervention. It also addresses privacy concerns by processing sensitive patient data locally and minimizing data transmission to external servers.

7.4 Transportation and Logistics: Edge computing has significant applications in transportation and logistics, particularly in areas such as autonomous vehicles, fleet management, and supply chain optimization. Edge devices and servers deployed in vehicles, logistics hubs, and warehouses enable real-time data analysis, route optimization, predictive maintenance, and intelligent decision-making. Edge computing improves safety, reduces congestion, enhances energy efficiency, and optimizes logistics operations, resulting in improved transportation systems and supply chain management.

These case studies illustrate the diverse applications of edge computing in real-world scenarios. From smart cities and industrial IoT to healthcare and transportation, edge computing is revolutionizing various sectors by enabling real-time analytics, low-latency

processing, and localized decision-making. These applications highlight the potential of edge computing to drive innovation, enhance efficiency, and deliver transformative outcomes in different domains.

CONCLUSION

8.1 Summary of Findings: In this research paper, we have explored the concept of edge computing in the context of IoT systems. We discussed the efficiency improvements achieved through edge computing, including reduced latency and bandwidth requirements, real-time decision making, distributed analytics, and resource optimization. Additionally, we examined the security enhancements provided by edge computing, such as reducing the attack surface, local threat detection, data encryption, and secure communication. Furthermore, we discussed privacy considerations in edge computing, including minimizing sensitive data transmission, local data processing, user control over personal information, and privacy-preserving techniques.

Moreover, we highlighted the challenges and future directions in the field of edge computing, including resource constraints, management complexity, scalability, interoperability, and integration with cloud and fog computing. We also emphasized the importance of edge intelligence and machine learning at the edge to unlock the full potential of edge computing in IoT systems.

8.2 Contributions to the Field: This research paper contributes to the field of edge computing in IoT by providing a comprehensive overview of its concepts, characteristics, and architectural aspects. It highlights the efficiency, security, and privacy benefits that edge computing brings to IoT systems. The exploration of challenges and future directions provides valuable insights for researchers and practitioners working in this area. Additionally, the case studies presented in real-world applications demonstrate the practical impact of edge computing across diverse domains.

8.3 Implications and Future Research Directions: The findings of this research paper have several implications for the industry and academia. Organizations can leverage edge computing to enhance the efficiency, security, and privacy of their IoT deployments. The insights provided can guide the development of edge computing solutions that address resource constraints, management complexity, scalability, and interoperability challenges.

Future research directions in edge computing include developing resource-efficient algorithms for edge devices, designing robust management and orchestration frameworks, exploring scalable architectures and interoperability frameworks, investigating integration strategies with cloud and fog computing, and advancing edge intelligence and machine learning techniques. Moreover, addressing the implications of edge computing in specific domains such as agriculture, healthcare, and transportation warrants further investigation.

In conclusion, edge computing is a transformative technology that empowers IoT systems with enhanced capabilities and addresses critical concerns of efficiency, security, and privacy. By understanding the concepts, challenges, and future directions outlined in this

research paper, researchers and practitioners can advance the field of edge computing and unlock its full potential in shaping the future of IoT systems.

REFERENCES

[1] Satyanarayanan, M. (2017). The emergence of edge computing. Computer, 50(1), 30-39.
[2] Zhang, Y., Zhang, Z., Chen, Y., Hu, F., & Hua, D. (2018). Edge computing for the internet of things: A case study. IEEE Internet of Things Journal, 5(2), 1275-1284.
[3] Shi, W., Cao, J., Zhang, Q., Li, Y., & Xu, L. (2016). Edge computing: Vision and challenges. IEEE Internet of Things Journal, 3(5), 637-646.
[4] Yang, C., & Zhang, Z. (2019). A survey on edge computing technologies for Internet of Things. IEEE Access, 7, 16450-16467.
[5] Chen, M., Zhang, Y., Zhang, L., & Yang, Y. (2019). Edge computing-based internet of things: Vision, challenges, and research opportunities. IEEE Internet of Things Journal, 6(5), 8256-8264.
[6] Roman, R., Zhou, J., & Lopez, J. (2018). On the features and challenges of security and privacy in distributed Internet of Things. Computer Networks, 135, 104-117.
[7] Li, P., Zhang, J., & Chen, Z. (2019). Secure and privacy-preserving data sharing and collaboration in edge computing. IEEE Network, 33(3), 18-24.
[8] Yao, Y., Tang, Y., Xiao, H., & Yu, F. R. (2018). Privacy-preserving machine learning in edge computing. IEEE Network, 32(6), 60-67.
[9] Gomes, T., Rodrigues, J. J. P. C., & Pereira, P. (2017). Edge computing for privacy-preserving IoT-based real-time video surveillance. IEEE Communications Magazine, 55(10), 44-49.
[10] Li, F., Li, W., & Huang, J. (2020). Edge computing for precision agriculture in the IoT era: A survey. IEEE Internet of Things Journal, 7(9), 8446-8460.

CHAPTER-2.4

A Review on Models for Low Power VLSI Design in Different Circuits

Rakesh Kumar[1], Dr. Sunil Kumar[2], Surabhi Chauhan[1]
[1]Assitant Professor, JB Institute of Technology, Dehardun, India, 248197
[2]Associate Professor, JB Institute of Technology, Dehardun, India, 248197
raahkesh@gmail.com

Abstract: *One of the main objectives for each integrated circuit is low power design. A type of integrated circuit (IC) known as very large-scale integration (VLSI) is made up of countless transistors connected together on a tiny chip. The advancement of VLSI circuit design, such as microcontroller and microprocessors, has accelerated the growth of computer and communication applications over the past ten years. However, VLSI development is still advancing more quickly in the direction of power and area reduction. The paper provides a summary of the most recent approaches that have been created to enhance the performance of VLSI design and it outlines the future directions of the areas that will be focused on VLSI circuit design.*

Keywords: CMOS, leakage power, transistor reduction, logic gates, low-power circuits

INTRODUCTION

The power density of electronic circuits has increased even while transistor miniaturisation has somewhat lowered the power consumption of those circuits. Maintaining processing power while using less energy is the main problem of creating a low power VLSI circuit [1]. In a similar vein, the circuits are built to function with more new and distinctive features than their earlier designs. This leads to the creation of potent processors that can be used in applications for data processing and computer vision. As a result, the power density in the VLSI circuit is improved [2, 3].

In order to retain the scalability and dependability of the circuits without losing their nature, specific design techniques are used today to improve the performances of such circuit designs. The general benefits of using a VLSI-based circuit model are shown in Figure 1. The VLSI circuits are equipped with a hardware-based power maintenance mechanism since low power devices are crucial to extending battery life.

Reduced power usage lowers the circuit's heat dissipation and reduces the amount of room needed for airflow on the circuit board [4]. A circuit's power consumption can be managed in two phases: the active period and the standby phase.

ACTIVE PHASE: The power taken into account for the circuit's operation is included in the active phase power supply. The power needed to charge and discharge the transistor capacitance installed inside a VLSI circuit is generally included. As a result, CMOS logic is used to design VLSI circuits in order to reduce power consumption, which is done by minimising switching operations during operational stages.

STANDBY PHASE: Energy used for operation and circuit leakage are combined to form the standby power consumption. The transistor's gate terminals allow some current to escape

over the circuit, which causes the circuit to dissipate heat. As a result, bi-polar circuit designs are frequently avoided.

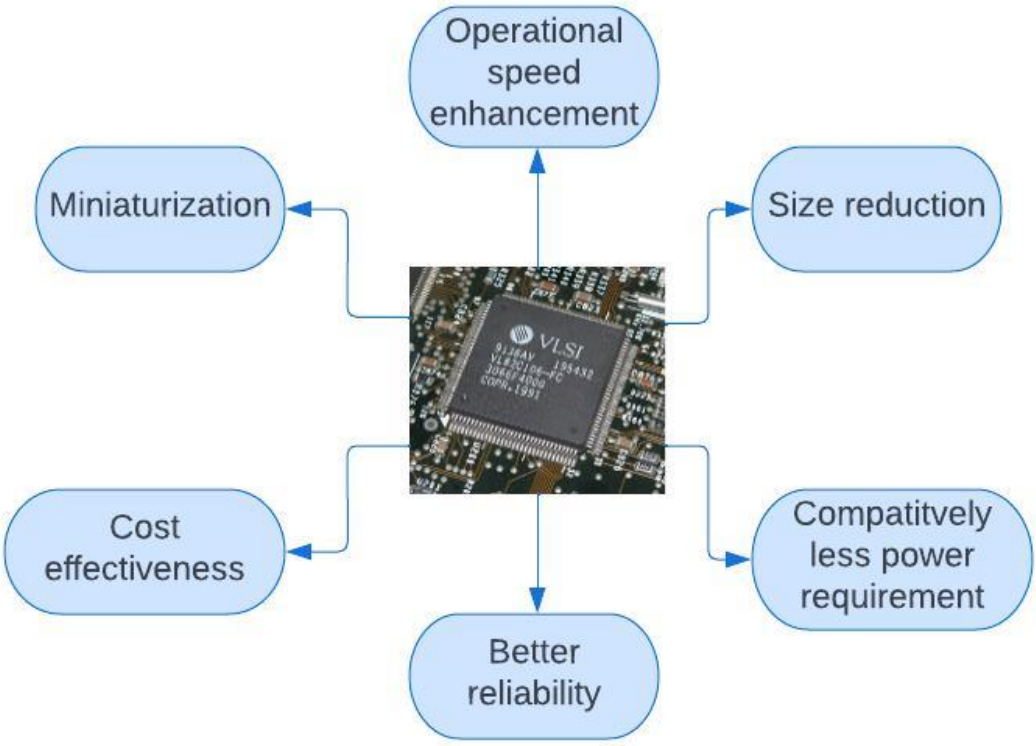


Figure 1. Merits of VLSI design

The following cutting-edge techniques are used in numerous applications to reduce the power consumption of VLSI circuits and can be applied without significantly altering transistor logic [5].

VOLTAGE SCALING: By altering the logic level of the voltages in either direction, the power consumption of the circuits can be managed. The logic level should be kept at its lowest point during the changeover phase to reduce power usage.

FREQUENCY SCALING: The frequency result of the circuit can also be changed in any direction depending on its requirements, similar to voltage scaling. The power leakage in a logic circuit will be reduced by making the best frequency range choice.

CLOCK GATING: The current leakage in the non-operated logic circuits is decreased by removing some logic units from the circuit when they are not needed for operation.

BIAS CONTROL: Scaling techniques are used in conjunction with the bias control technique to estimate the transistor voltage entry threshold. When a threshold value is used to adjust the CMOS voltage while it is operating, it is also described as a back scaling procedure.

The list of recent techniques created to maintain low power consumption in VLSI architectures is explored in the section that follows.

LITERATURE SURVEY

As IC modules are installed in locations without access to energy sources, the demand for low power VLSI devices is rising. Applications like IoT and WSN demand that their systems run on very low power battery sources. The list of methods proposed to handle the problem of VLSI modules' power requirements in various applications is explored in Table 1.

Table 1. Survey on low power design methodologies

First author name & citation	Technique	Methodology	Application	Outcome
Amini-Valashani [6]	Inverter logic modification	Feedback loop	Hybrid full adder	Avg. power Proposed = 3.79µW Hybrid CMOS = 14.32µW
Sowmya [7]	Multiple logic operation	Transistor reduction	Full adder	Avg. power Proposed = 41.91 µW Existing = 21.24 µW
Razavi [8]	Markov random field	Logic state optimization	Low power VLSI circuit	Avg. power Proposed = 553.59 pW Existing = 1129.8 pW
Kalavathi Devi [9]	Viterbi decoder utilizing a sleepy keeper method	Transistor leakage current control	WLAN	Avg. power Proposed = 0.85mW Existing power = 1.67mW
Singh [10]	Inverter logic	Transistor reduction	Hybrid full adder	Avg. power = 6.889µW
Kumar [11]	NMOS Stacking	Leakage current reduction	45nm CMOS VLSI circuit	21.97µW power difference over VCDG technique
Vidhyadharan [12]	Dynamic Comparator	Transistor ON-OFF	Gate Overlap	Avg. power Proposed = 1.11pW

	design	control	Tunnel FET	CMOS = 154pW
Thamaraimanalan [13]	Delay-based power gating technique	Transistor ON-OFF control	Adders and multipliers	Leakage power on (16 bit adder): Proposed = 98.65 µW
Cai [15]	18TSPC topology	Transistor reduction	Single phase flip flop	27% of lower leakage current over TGFF

DISCUSSION

It has been discovered that transistor count reduction and transistor logic control are the most widely employed methods for lowering the power consumption on VLSI circuits. Routing and optimization-based control approaches are only occasionally found [6]. Similar to this, the performance enhancement of each proposed solution is compared to the conventional CMOS methodology [4, 5]. The optimisation approach and path controlling strategy are sometimes used to control transistor logics.

By introducing additional transistors to keep the prior transistor's logic state stable, a sleepy keeper approach was discovered [12]. These approaches improve the amount of space needed for the VLSI circuit while consuming less power. However, a good VLSI circuit design must trade off reduced power usage for space and heat dissipation requirements.

CONCLUSION

By including more transistors and logic circuits in a microchip, VLSI circuits are built to handle the most difficult arithmetic operations. From a basic calculator to the most sophisticated neural network-based application, VLSI microchips are present. The power requirement of such circuits increases as a result of the constant and demanding operations. The microchips generate more heat with the increased power demand than they would normally. Thus, a variety of operational logics are developed daily to reduce the power consumption of VLSI circuits. The transistor reduction technique is the power-saving strategy that is most frequently used, according to a summary of contemporary techniques in the study that aim to reduce the power consumption of VLSI processors. However, it must be compared against the performance of recently developed designs in order to demonstrate the effectiveness of a developed technique. Additionally, the study found a markedly different performance between the simulated and practical studies. The negative side of the simulation setup varies slightly from the practical experiments.

REFERENCES

[1] Moradinezhad Maryan, Mohammad, Majid Amini- Valashani, and Seyed Javad Azhari. "An input controlled leakage restrainer transistor- based technique for leakage and short- circuit power reduction of 1- bit hybrid full adders." International Journal of Circuit Theory and Applications 49, no. 8 (2021): 2382-2395.

[2] Mallaraddi, Vidyavati, and H. P. Rajani. "An Approach to Diminish the Leakage Power in Complementary MOS VLSI Circuits." Advances in Electrical and Computer Technologies (2021): 595-611.
[3] Murugan, S. Vijay, and B. Sathiyabhama. "Bit-swapping linear feedback shift register (LFSR) for power reduction using pre-charged XOR with multiplexer technique in built in self-test." Journal of Ambient Intelligence and Humanized Computing 12, no. 6 (2021): 6367-6373.
[4] Sharma, Vijay Kumar. "A survey of leakage reduction techniques in CMOS digital circuits for nanoscale regime." Australian Journal of Electrical and Electronics Engineering 18, no. 4 (2021): 217-236.
[5] Karunakaran, S. "VLSI Implementation of a High Speed Multiplier Using on the Fly Conversion Technique." ECS Transactions 107, no. 1 (2022): 2329.A REVIEW ON LOW POWER VLSI DESIGN MODELS IN VARIOUS CIRCUITS ISSN: 2582-3825 80
[6] Kalavathi Devi, T., E. B. Priyanka, P. Sakthivel, and A. Stephen Sagayaraj. "Sleepy keeper style based Low Power VLSI Architecture of a Viterbi Decoder applying for the Wireless LAN Operation sustainability." Analog Integrated Circuits and Signal Processing 109, no. 3 (2021): 487-499.
[7] Singh, Salam Surjit, Dolly Leishangthem, Md Nasiruddin Shah, and Biraj Shougaijam. "A Unique design of hybrid full adder for the application of low power VLSI circuits." In 2020 4th international conference on electronics, communication and aerospace technology (ICECA), pp. 260-264. IEEE, 2020.
[8] Kumar, Ankur, and R. K. Nagaria. "A new leakage-tolerant high speed comparator based domino gate for wide fan-in OR logic for low power VLSI circuits." Integration 63 (2018): 174-184.
[9] Vidhyadharan, Sanjay, Ramakant Yadav, Hariprasad Simhadri, and Surya Shankar Dan. "A nanoscale gate overlap tunnel FET (GOTFET) based improved double tail dynamic comparator for ultra-low-power VLSI applications." Analog Integrated Circuits and Signal Processing 101, no. 1 (2019): 109-117.
[10] Tirumalasetty, Venkata Rao, and Madhusudhan Reddy Machupalli. "Design and analysis of low power high-speed 1-bit full adder cells for VLSI applications." International Journal of Electronics 106, no. 4 (2019): 521-536. [11] Vidhyadharan, Abhay S., and Sanjay Vidhyadharan. "A novel ultra-low-power CNTFET and 45 nm CMOS based ternary SRAM." Microelectronics Journal 111 (2021): 105033.
[12] Barla, Prashanth, Vinod Kumar Joshi, and Somashekara Bhat. "A novel low power and reduced transistor count magnetic arithmetic logic unit using hybrid STT-MTJ/CMOS circuit." IEEE Access 8 (2020): 6876-6889.
[13] Amini-Valashani, Majid, Mehdi Ayat, and Sattar Mirzakuchaki. "Design and analysis of a novel low-power and energy-efficient 18T hybrid full adder." Microelectronics journal 74 (2018): 49-59.
[14] Vidhyadharan, Sanjay, and Surya Shankar Dan. "An efficient ultra-low-power and superior performance design of ternary half adder using CNFET and gate-overlap TFET devices." IEEE Transactions on Nanotechnology 20 (2021): 365-376.
[15] Cai, Yunpeng, Anand Savanth, Pranay Prabhat, James Myers, Alex S. Weddell, and Tom J. Kazmierski. "Ultra-low power 18-transistor fully static contention-free single phase clocked flip-flop in 65-nm CMOS." IEEE Journal of Solid-State Circuits 54, no. 2 (2018): 550-559.*S. Madhura* Journal of Electronics and Informatics, June 2022, Volume 4, Issue 2 81
[16] Thamaraimanalan, T., and P. Sampath. "Leakage power reduction in deep submicron VLSI circuits using delay-based power gating." National Academy Science Letters 43, no. 3 (2020): 229-232.
[17] Thangavel, Kalavathi Devi, and Sakthivel Palaniappan. "Low power sleepy keeper technique based VLSI architecture of Viterbi decoder in WLANs." Australian Journal of Electrical and Electronics Engineering 17, no. 4 (2020): 263-268.
[18] Sowmya, Pabba, D. Lakshmaiah, J. Manga, Gunturu Sai Shankar, and Desham Sai Prasad. "Design of Dayadi 1-bit CMOS Full Adder Based on Power Reduction Techniques." In Advances in Decision Sciences, Image Processing, Security and Computer Vision, pp. 89-96. Springer, Cham, 2020.
[19] Elango, Konguvel, and Kannan Muniandi. "VLSI implementation of an area and energy efficient FFT/IFFT core for MIMO-OFDM applications." Annals of Telecommunications 75, no. 5 (2020): 215-227.
[20] Razavi, Sayyed Mohammad, and Seyyed Mohammad Razavi. "An efficient and reliable MRF-based methodology for designing low-power VLSI circuits." Integration 73 (2020): 77-88.

CHAPTER-2.5

Exploring the Efficiency of MATLAB in Solving Complex Optimization Problems

Shikha Tayal
Associate Professor, JBIT Group of Institutions, Dehradun, India, 248001
shikha.tayal@gmail.com

Abstract-*Our daily lives depend heavily on optimization.In many fields, including engineering and non-engineering sectors, there are numerous optimization problems that may need the best possible solution. The solution finding process for traditional optimization techniques takes longer and involves more iterations. Consequently, it is not practical to apply in cases when there are many variables. MATLAB is a powerful tool for solving a wide range of problems, from basic numerical computations to complex optimization Problems. This paper will explore the efficiency of MATLAB in solving such complex optimization problems. Whether addressing linear programming, nonlinear optimization, or multi-objective problems, the Optimization Toolbox provides a robust and efficient framework for tackling optimization challenges.*

Keywords-Optimization toolbox, LPP, NLPP, Problem-based Solver*.*

INTRODUCTION

Optimization problems are important in various fields due to their ability to maximize efficiency, minimize costs, improve performance, and make informed decisions. They involve a large number of variables, constraints, and objectives, as well as multiple, conflicting objectives. Additionally, they require domain expertise and an understanding of the problem context. Optimization is an important technique used in engineering, economics, logistics, supply chain management, healthcare, transportation, telecommunications, marketing, and environmental management. It can lead to cost savings, improved efficiency, reduced waste, and enhanced decision-making. It poses challenges due to complexity, nonlinear relationships, and conflicting objectives, but by addressing them and leveraging optimization techniques, researchers and practitioners can unlock efficiency gains, cost savings, and improved decision-making.

MATLAB is a powerful prototyping and iterative development tool, with intuitive syntax and visualization capabilities. It also provides support for handling and analyzing large datasets, and its matrix-based approach simplifies complex calculations. It is compatible with other programming languages and software packages, making it a valuable tool for solving a wide range of problems. MATLAB's built-in functions and toolboxes enable researchers to tackle complex problems efficiently. As shown in Figure 1, its features and capabilities make it a valuable tool for solving a wide range of problems, from basic numerical computations to complex optimization Problems.

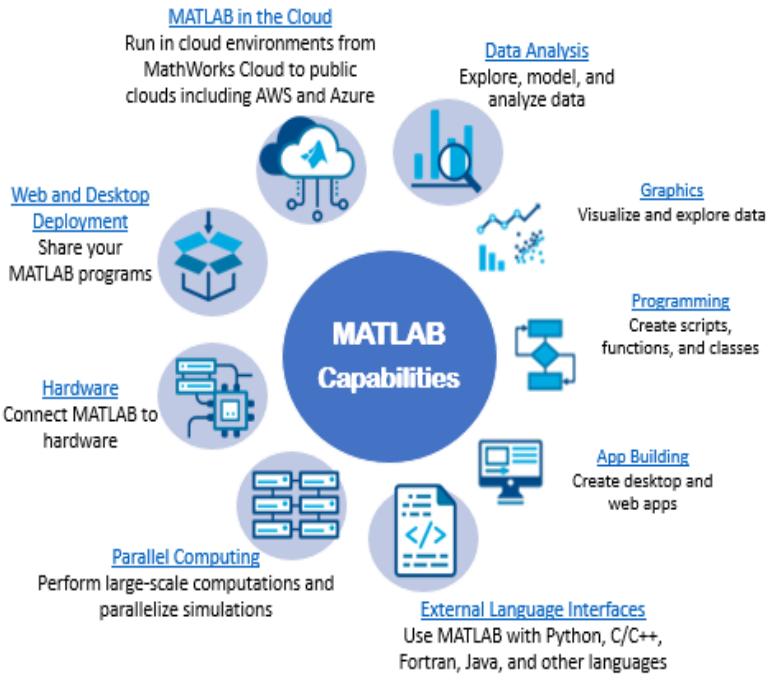


Fig 1- Features and capabilities of MATLAB

MATLAB OPTIMIZATION TOOLBOX: A COMPREHENSIVE REVIEW

The MATLAB Optimization Toolbox is an effective set of tools, methods, and algorithms created to tackle a variety of optimization issues. The Optimizations Toolbox provides academics, engineers, and practitioners with a flexible framework for handling challenging optimization problems successfully and quickly thanks to its wide range of features. The toolbox includes routines for many types of optimizations including

- Unconstrained nonlinear minimization,
- Constrained nonlinear minimization,
- Quadratic and linear programming
- Nonlinear least squares and curve-fitting
- Nonlinear system of equation solving
- Constrained linear least squares

All of the toolbox functions are MATLAB M-files, made up of MATLAB statements that implement specialized optimization algorithms. One can extend the capabilities of the Optimization Toolbox by writing their own M-files, or by using the toolbox in combination with other toolboxes, or with MATLAB, or Simulink as shown in Figure 2.

Optimization Toolbox has two approaches to solving optimization problems or equations: problem-based and solver-based. In the problem-based approach, one can use symbolic-style variables to create optimization expressions and constraints.This approach requires translation from problem form to matrix form, resulting in a longer solution time. Whereas, in the solver-based approach, one must place all variables into a single vector this approach

does not require translation from problem form to matrix form, resulting in a shorter solution time. Also, multi-objective problems can be solved easily by a solver-based approach.

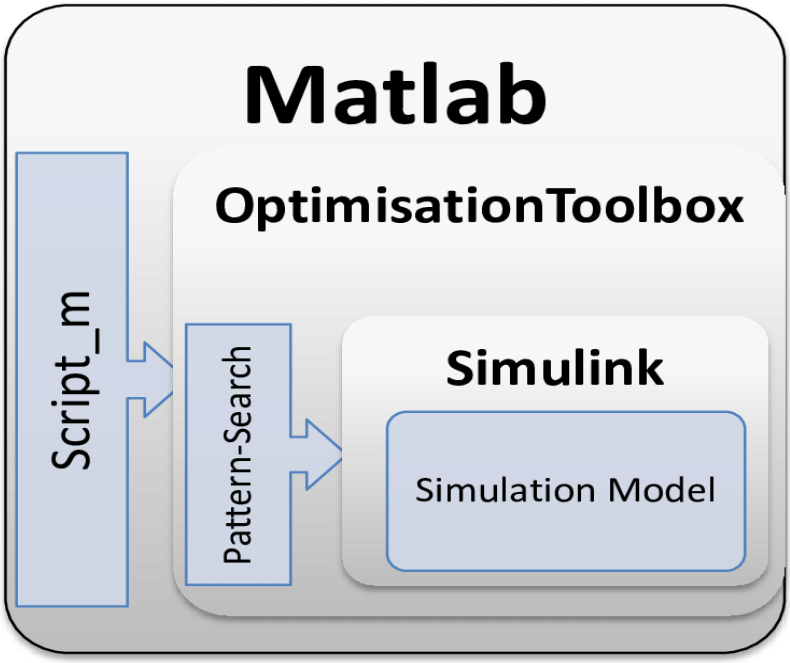


Fig 1.2- Matlab Optimization Toolbox

Optimization Toolbox solvers are grouped into four general categories:

Minimization: Solvers for minimization type are used to find a minimum of the objective function near a starting point x0. They consist of a linear programming problem, a non-linear programming problem unconstrained optimization, quadratic programming, cone programming, etc. Table 1.1 shows the functions available for minimization problems.

Table1-1:Minimization

Type	Function
Scalar Minimization	fminbnd
Unconstrained Minimization	fminunc, fminsearch
Linear Programming	linprog
Quadratic Programming	quadprog
Constrained Minimization	fmincon
Goal Attainment	fgoalattain
Minimax	fminimax
Semi-infinite Minimization	fseminf

Multi-objective minimization: Solvers for multi-objective minimization type are used to find either to minimize the maximum value of a set of functions (fminimax), or to find a location where a collection of functions is below some specified values (fgoalattain).

Equation solvers: Equation solvers are used to find a solution to a scalar- or vector-valued nonlinear equation f(x) = 0 near a starting point x0. Equation solving can be considered a form of optimization because it is equivalent to finding the minimum norm of f(x) near x0. Table 1.2 shows the functions available for equation-solving problems.

Table 1-2: Equation Solving

Type	Function
Linear Equations	\ (slash)
Nonlinear Equation of One Variable	fzero
Nonlinear Equations	fsolve

Least-Squares Solvers: Least square solvers are used to minimize a sum of squares. This type of problem frequently arises in fitting a model to data. The solvers address problems of finding non-negative solutions, finding bounded or linearly constrained solutions, and fitting parameterized nonlinear models to data. The table 1.3 shows the functions available for solving least squares or data fitting problems.

Table 1-3: Least-Squares (Curve Fitting)

Type	Function
Linear Least Squares	\(slash)
Nonnegative Linear Least Squares	lsqnonneg
Constrained Linear Least Squares	lsqlin
Nonlinear Least Squares	lsqnonlin
Nonlinear Curve Fitting	lsqcurvefit

Overall, the MATLAB Optimization Toolbox offers a comprehensive and versatile set of tools for solving optimization problems. Its rich collection of algorithms, functions, and tools, combined with its integration with other MATLAB capabilities, makes it a valuable resource for researchers and practitioners in various domains. Whether addressing linear programming, nonlinear optimization, or multi-objective problems, the Optimization Toolbox provides a robust and efficient framework for tackling optimization challenges.

EFFICIENCY ANALYSIS

Comparing MATLAB's Optimization Algorithms: Efficiency is crucial when selecting an optimization algorithm, as it directly impacts the computational time required to find an optimal solution. The MATLAB Optimization Toolbox offers a diverse range of optimization algorithms, each with its own strengths and characteristics. Conducting an efficiency analysis by comparing these algorithms can provide valuable insights into their performance and suitability for different optimization problems.Table 1.4 shows the comparison between different types of optimization algorithms.

Table 1.4 Comparing Matlab's Optimization Algorithms

Optimization Algorithm	Problem Types	Pros	Cons
Simplex Method	Linear Programming (LP)	Easy to understand and implement	Inefficient for large-scale problems
Interior-Point Method	Linear Programming (LP)	Efficient for large-scale problems	Complexity increases for larger and more complex problems
Active-Set Method	Quadratic Programming (QP)	Exploits problem structure	May have limitations with highly complex or large-scale problems
Trust-Region Reflective	Nonlinear Programming (NLP)	Handles both equality and inequality constraints	Convergence can be slow for highly non-linear problems
Sequential QuadraticProgramming (SQP)	Nonlinear Programming (NLP)	Efficient for non-linear constrained optimization problems	Complexity increases for large-scale problems
Genetic Algorithm	Global Optimization	Suitable for non-linear, non-convex, and multimodal problems	Can have longer computational time due to population-based approach
Particle SwarmOptimization (PSO)	Global Optimization	Efficient for problems with continuous variables	Requires careful parameter tuning for optimal performance
Simulated Annealing	Global Optimization	Escapes local optima and explores complex landscapes	Computational time can vary significantly based on problem size and complexity

CONCLUSION

MATLAB provides a powerful platform for solving complex optimization problems. It offers a diverse range of algorithms that cater to various problem types and constraints. For linear programming, the simplex method and interior-point methods offer viable solutions. For

nonlinear programming, trust-region reflective algorithms and sequential quadratic programming (SQP) offer good computational time. Global optimization problems can be solved using genetic algorithms, PSO, or simulated annealing.

REFERENCES

[1] Davis, T. A. (2017). Direct Methods for Sparse Linear Systems. Society for Industrial and Applied Mathematics.
[2] Gill, P. E., Murray, W., & Wright, M. H. (1981). Practical Optimization. Academic Press.
[3] Hahn, J. (2016). Optimization Toolbox User's Guide. MathWorks.
[4] Kolda, T. G., Lewis, R. M., &Torczon, V. (2003). Optimization by Direct Search: New Perspectives on Some Classical and Modern Methods. Society for Industrial and Applied Mathematics.
[5] Michalewicz, Z., & Fogel, D. B. (2004). How to Solve It: Modern Heuristics. Springer.
[6] Rao, S. S. (2009). Engineering Optimization: Theory and Practice. John Wiley & Sons.
[7] Schrijver, A. (2003). Combinatorial Optimization: Polyhedra and Efficiency. Springer.
[8] Snyman, J. A. (2005). Practical Mathematical Optimization: An Introduction to Basic Optimization Theory and Classical and New Gradient-Based Algorithms. Springer.
[9] Törn, A., &Zilinskas, A. (2012). Global Optimization. Springer.
[10] Wright, S. J. (2014). Numerical Optimization: Methods, Algorithms, and Applications. Springer.

INTEGRATED SOLUTIONS: ELECTRICAL ENGINEERING

CHAPTER-3.1

Common Goals and New Requirements for Renewable Energy Grid Integration Technical Standards

Vivek Kumar Yadav[1], Deepak Kr. Verma[2]
[1,2]Assistant Professor, JB Institute of Technology, Dehradun, Uttarakhand 248197

ABSTRACT: *Technical guidelines for the integration of renewable energy sources into the grid have been created over the past ten years in the majority of nations in Europe, North America, and China. Power grid businesses or an electricity organisation. However, more nations are confirming the legitimacy of renewable energy grid integration rules through national legislation as a result of the growing scale of renewable energy output and its constantly intensifying impact on the power system. The grid codes for renewable energy integration in different nations are not the same because of variations in the structure of the power source, the characteristics of the load, the state of the power system, and other particular situations in different countries or areas. These technological standards do, however, share some similar objectives. They all emphasised that the renewable energy power plants must be able to control active power, reactive power/voltage, and fault ride through in addition to being able to endure voltage and frequency deviation in the power system. Some of the standards demand model data, operating parameters, and grid integration performance testing reports from the renewable energy power plants. This essay introduces the general focus on technical grid integration standards for renewable energy and attempts to examine potential problems brought on by RE grid integration.*

Keywords- Renewable Energy, Technical Standards, Common Focus, Grid Integration.

INTRODUCTION

The majority of electrical associations or power grid firms have produced technical standards for renewable energy grid integration over the past ten years throughout most of Europe, North America, and China. However, more nations are confirming the legitimacy of renewable energy grid integration rules through national legislation as a result of the growing scale of renewable energy output and its constantly intensifying impact on the power system. Wind power grid-connected codes that are appropriate for each country's national circumstances have been repeatedly issued by nations with early growth of wind power in the world, taking into account the influence of wind power grid-connected on the electricity system. The Danish ELTRA transmission business published a grid-linked rule in 2000 to set the technical specifications for the electricity system connected to wind farms. The National Grid Corporation of Ireland created a technical regulation for connecting wind farms to the grid in 2002. Technical guidelines for the integration of wind farms into the grid were jointly proposed by the Scottish Transmission and Distribution Company and the Scottish Hydropower Company. A grid-connected standard for connect to high-voltage power grids was released in 2003 by the E. ON transmission grid company, which in Germany has installed the most wind energy. This standard specified general technical requirements for power supplies, including wind energy, connected to its high-voltage power grid. Decree No. 661, Wind Power Integration Procedures, was published in 2005 by the US Federal Energy

Regulatory Commission (FERC). The grid code for wind power integration in different nations is continually being updated and enhanced as wind power technology advances.

On December 12, 2005, China published the national standard technical guidance document "Technical Rule for Connecting with Wind Farm to Power Systems" (GB/Z 19963-2005) in order to direct and assist the development of large-scale wind power integration. The initial proposal concerned the technical specifications for connecting a wind farm to the electrical grid. The guideline suitably lowers the technological specifications for wind farms because China's wind power industry is still in its infancy and is still in the early stages of growth. China has been leading the updating of national standards for wind power integration since 2009.

The revision process makes use of superior worldwide expertise and completely takes into account the current state of wind power development in China. The recommended national standard GB/T 19963 -2011 was published in December 2011 and will go into effect on June 1, 2012. The updated grid code now includes pertinent information on wind farm active and reactive control, wind power output forecasting, low voltage ride through capability, testing, etc. It also includes suggested technical specifications and specific performance indicators for large wind power bases with a 1-million-kilowatt capacity. The pertinent specifications for dynamic reactive power are put forward.

However, as grid integration of renewable energy grows in scope, certain new issues with how renewable energy operates will progressively emerge, and this will undoubtedly become the industry's and research's main emphasis 3720. This paper attempts to explore the upcoming problem brought on by the connection of renewable energy generation to power systems and provides an introduction to the general focus on technical standards of renewable energy grid integration.

COMMON FOCUS ON RENEWABLE ENERGY GRID INTEGRATION TECHNICAL STANDARDS

The grid codes for renewable energy integration in different nations are not the same because of variations in the structure of the power source, the characteristics of the load, the state of the power system, and other particular situations in different countries or areas. These technological standards do, however, share some similar objectives. They all emphasised that the renewable energy power plants needed to have specific active power control, reactive power, fault ride through capabilities, as well as the capacity to resist the voltage and frequency deviation of the power system. Some of the standards demand model data, operating parameters, and grid integration performance testing reports from the renewable energy power plants.

1. ACTIVE POWER CONTROL

Renewable energy generation must be controlled as an active power in order to control the active power that comprises an increasing number of renewable energy producing system functions. In order to generate electricity and balance the load, the power grid must supply

adequate power to the power market. The final dispatch of the power plant also takes the grid's need for stability and the cap on transmission capacity into account.

Renewable energy generators can typically adjust the output between the rated power and the minimum power level once they have integrated power. However, there are few minimal operating levels for renewable energy sources, which depend on the resource's external conditions to generate viable output power. It is extremely different from traditional generator systems since the output power of renewable energy generators depends mostly on the availability of wind speed and solar power radiation.

The power plant's scheduling system may regulate the production of renewable energy, and when sufficient resources are on hand for a higher output, the generator will limit its output appropriately. They have the ability to power the grid and can switch between operating at rated output and minimum output. However, there aren't many minimum operating levels for renewable energy generators, and they depend on the environment to produce useful output power. The plant scheduling system connects renewable energy generation by swapping maximum output levels. The generator will then set a limit on its power output when enough resources are available for a higher output. Even in power markets based on allocations of renewable energy priorities, managing the active power of renewable energy generators is ideal. This is so that they can afterwards aid in stabilizing grid congestion management. When a considerable portion of renewable energy is produced, active power management capabilities should be made available to renewable energy generators.

These are the key issues:

- In order to manage grid stability and congestion, the power system operator needs to link to the power plant dispatch.
- Generators of renewable energy are connected to active power management, and power output restrictions are enforced. Therefore, facilities must be integrated into renewable energy systems in order to link and comply with these limitations.
- Even in the electrical market/regulation, renewable energy generators using priority scheduling for renewable energy generation must offer the features of active power management.

2. REACTIVE POWER CONTROL

To keep the voltage in the system within the specified range, the power system operator controls the reactive power generated by the generator. Large power plants' conventional generators offer a variety of reactive power capabilities. Due to varying generating technologies, renewable energy generators themselves do not offer a comparable range of capabilities. In contrast, while building a renewable energy generator, the range of reactive power needed must be carefully taken into account, as this can significantly affect the generator cost.

In two ways, the increased reactive power capability of renewable energy producers can help boost the amount of renewable energy generation penetration. First, distribution networks may use reactive power to lessen the voltage change brought on by active power injection from distributed generators. When you don't need to upgrade your network gear, you can connect to more installed capacity, which helps cut expenditure. Second, transmission lines require reactive power when renewable energy output takes the place of conventional power plants. The huge reactive power range helps to lower the conventional operational capacity needed to meet voltage control requirements because it is at least on par with the greatest renewable energy sources.

These are the key issues:

- With a large reactive power capability and controllability, higher RE penetration would be permitted.
- Side reactive power capability can aid in reducing the distribution system's need for grid reinforcement brought on by RE integration.
- Reduced need for traditional must-run capacity in the gearbox system is made possible by wide-ranging RE power plant reactive power capability.

3. FREQUENCY CONTROL

One global parameter in a synchronous AC power system is frequency. It is possible to manage the balance between generation and load within a narrow range close to the nominal value by maintaining it at the gearbox system level. The biggest threat to frequency stability, as long as there is enough generating power to handle the demand, is an abrupt shift in power balance. This imbalance may be brought on by a failure that results in a heavy load, the power plant being disconnected, or a very quick shift in the output power of numerous RE generators spread out across the area. To continuously balance and reduce frequency changes in the load within the control region, the operators maintain power reserves.

Generators for renewable energy rely on the erratic availability of the system's primary energy. The load must be balanced with the entire quantity of energy produced by the conventional power plant from the perspective of the system plant dispatcher, who has priority feed from renewable energy generation. The frequency control strain that the conventional power must endure can be reduced by modifying the power of the energy generator to fulfil the requirement of power balancing during interference. As a result, it promotes greater energy permeability while retaining the same level of frequency stability. The anticipated generator reaction to frequency interference relies on the type of imbalance. Overly high frequency indicates excessive power generation. In this situation, less power should be added to the system. In order to prevent a decline in load, power injection needs to be increased because low frequency signals insufficient power generation.

These are the key issues:

- Renewable energy sources are not particularly well-suited to regulating frequency. However, the production of renewable energy can be used to support precautions against frequency interference.
- The renewable energy generator should initially progressively reduce its power output while remaining connected to the grid if the frequency is too high. They must only be disconnected when there is enough rated frequency margin and a predetermined threshold. Most recommendations for the grid-connection of power produced by renewable energy sources now include such requirements.
- Renewable power plants must be able to run in a reduced output mode in order to supply backup power at low frequencies. The abandonment of wind and light in favor of free primary energy is involved in this, a topic that is still being contested in the majority of nations due to concerns with power markets and priority supply.

4. FAULTS RIDE DESPITE

A power system fault is an occurrence such a cable or overhead short circuit, circuit break, transformer, etc. High current from a short circuit will result in immediate physical damage to the equipment. They are also employed to accurately detect faults. Relays that detect such currents and shut down the asset are used to protect grid assets. The generator in the system supplies the high current during a short circuit and also aids in reducing the fault's voltage-related effects. The damaged component must be disconnected as soon as possible to avoid further harm. The generator itself must be connected during a fault in order to prevent any interference with proper fault detection.

To keep the system's power balance after troubleshooting, the generator must also be connected. Therefore, the specifications for producing renewable energy are comparable to those for conventional generators in terms of failure behaviour. The code accurately describes the circumstances in which the generator must continue to be connected to the grid following each initial voltage drop caused by a short circuit. Additionally, an ideal function to support current for fault detection must be injected into RE generation above the minimal size or voltage level. It is always limited by the underlying technology, though. Traditional generators have the capacity to deliver large short-circuit currents by nature. However, it must be taken into account while designing the generator to supply more current from the renewable energy generator than the rated current. It has a direct impact on generator costs.

These are the key issues:

- Renewable energy generators must keep their connection times to a minimum during grid outages due to the growth of permeability energy and the expansion of renewable power plants in order to protect the power balance.
- Due to technical restrictions, fault detection current injection levels from renewable energy sources are not as high as those from conventional generators. However, setting

reasonable minimal standards (such as capping current contributions at nominal current) can satisfy system needs.

1. POWER QUALITY

Voltage and current deviations from nominal values are related to waveform values and short-term fluctuations, in addition to amplitude and frequency. These variations should be measured using the proper techniques and categorised based on their features. These are referred to as power quality elements and are particular to a particular grid site and time interval.

All generators have an inherent effect on at least some aspects of the power quality in their immediate vicinity. The effects change between a standard generator and a typical renewable energy generator because they depend on the technology of the generator system. In order to guarantee that all linked users and equipment reach a certain voltage quality level, the renewable energy grid code codifies regulations that relate to various aspects of the generator's influence.

These are the key issues:

- Power quality refers to a variety of phenomena that are connected to voltage waveform and amplitude. The power quality will be impacted by every generator.
- The requirements for power quality would define the emission, voltage, and current restrictions for each asset connected to the system.
- All generators, including those that produce renewable energy, must abide by limits identical to those in Section 3722 in order to guarantee that power system customers receive the proper voltage quality higher standard.

NEW REQUIREMENT FOR RENEWABLE ENERGY GRID INTEGRATION TECHNICAL STANDARDS

Researchers and the energy sector will be concentrating on certain new issues with the functioning of renewable energy networks as the size of renewable energy grid integration, including wind and PV power, increases. It mostly consists of the following elements.

- The anti-disturbance capability likewise reduces at the system level as the moment of inertia rises. Wind and solar power generation make up more than 30% of the Northwest China power system and will reach 50% by 2020.The Northwest Power Grid's anti-disturbance capacity is equivalent to a decrease of 30% and 50% since wind power has a low moment of inertia, PV power has no moment of inertia, and the renewable energy generators are not involved in frequency and voltage regulation. The current DC power input has surpassed 20% of the East China power grid's power generation. This ratio will rise to above 40% by 2020, which will result in a 20% to 40% decline in East China Power's anti-disturbance capacity.

- The system's ability to regulate its frequency and voltage is diminished, and the likelihood of its entire frequency voltage is increased. an enhanced event. The ability of the system to regulate frequency and voltage continues to deteriorate as the output of renewable energy sources rises. It is simple to cause the frequency issue of the entire system when there is low system power. At the same time, the AC grid's short-circuit capacity is insufficient, and its ability to impact reactive power and regulate voltage is declining due to the rapid growth of renewable energy's grid-connected capacity. When the UHV DC transmission system's operating mode changes in the Northwest Power Grid, the power frequency overvoltage becomes more severe. Because the UHV DC converter station replaces the traditional power plants in the Central and East China Power Grids, the voltage control capability is significantly diminished, especially when the UHV DC transmission system encounters a commutation failure. Voltage breakdown becomes more likely as a result of the AC system absorbing a significant amount of reactive power.
- Wind turbines that are now plugged into the grid typically lack the capacity to ride through at high voltages. In the off-grid incident of the wind turbine in Northwest China on February 24, 2011, 274 were detached owing to low pressure and 300 were disconnected from excessive voltage. The risk of high-voltage off-grid of the UHV DC gearbox end is also exacerbated by the connecting of several UHV DC lines between the wind power base and the load centre. When the Hami-Zhengzhou, Zalute-Qingzhou UHV DC transmission line's UHV DC commutation fails, a large number of wind turbines close by go off-grid and experience transient overvoltages of 1.2–1.3 times the rated voltage. For UHV DC wind power transmission, there is a high-frequency offgrid risk as well. The frequency of the gearbox terminal following the bipolar blocking failure is lower than 52 Hz when Zalut-Qingzhou UHV DC power reaches 10 million kW, significantly beyond the present wind turbines. There is a chance that wind power will be used extensively off-grid at a level that can be tolerated. Similar hazards are present in the UHV DC transmission projects in Yinchuan-Shandong, Hami-Zhengzhou, Shanghaimiao-Shandong, etc. These risks have a significant impact on the security and stability of big power grids.
- The large-capacity UHV DC gearbox system has a major dynamic stability issue. On July 1, 2015, the subsynchronous oscillation in Tian-zhong UHV DC caused the three generators of the Garden Thermal Power Plant to trigger the shaft tensional vibration protection (TSR), resulting in a loss of 1.28 million kW overall. The AC grid continuously contains subsynchronous harmonic components of 16Hz–24Hz before and after the generator trips. The oscillation criterion is satisfied because the frequency of the generators shaft tensional vibration (frequency 30.76Hz) is complementary to the frequency of the subsynchronous harmonic component of the AC system (20Hz). The relevant generators have conducted study and offered solutions at various levels, but they haven't really identified the fundamental roots of the issues.

CONCLUSION

The technological standards must be revised in order to meet the greater requirements of large-scale renewable energy integration. However, it is important to consider the technology development state of manufacturing renewable energy equipment while revising the criteria. The technical advancement of renewable energy generators provide the necessary direction for wind turbine performance to gradually improve to an advanced degree on a global scale. From the manufacturer's present technical perspective, it is technically possible for renewable energy producers to accomplish high voltage ride through or engage in system frequency adjustment. Future trends in large-scale development of multi-million kilowatt renewable energy bases and long-distance UHV DC grid-connecting will emerge as the scope of renewable energy growth continues to grow. The super-large-scale renewable energy base takes the initiative to suppress the power system's phase angle jump when reactive voltage, active frequency, fault crossing, harmonic and weak grid, and the direction of subsynchronous oscillation suppression are present in the scenario of high-ratio renewable energy gridconnection. The requirements for the support capability should be the main concern.

ACKNOWLEDGMENT

Research on Key International Standards for Renewable Energy and Electric Vehicles, National Key R&D Programme 2016YFF0202702, is funding the effort.

REFERENCE

[1] Union for the Coordination of Electricity Transmission (UCTE)interim report - system disturbance on 4 November, 2006, 11-30.
[2] Specifications for Connecting Wind Farms to the Transmission Network. Transmission System Planning, Eltra. Apr. 2000.
[3] Wind Farm Power Station Grid Code Provisions [Z]. ESB National Grid. Ireland, 2002.
[4] Guidance note for the connection of wind farms [A]. SP Transmission and Distribution & Scottish Hydro-Electric, 2002.
[5] Grid code for high and extra high voltage. E.ON Netz GmbH, Bayreuth. Aug. 2003.
[6] Interconnection for Wind Energy. USA FERC Order No. 661. Jun. 2005.
[7] Wind Turbines Connected to Grids with Voltages above 100 kV, Technical regulation for the properties and the regulation of wind turbines. Elkraft System and Eltra. November 2004.
[8] Medium Voltage Directive, German Association of Energy and Water Industries (BDEW). 2008.
[9] ENTSO-E Draft Network Code for Requirements for Grid Connection applicable to all Generators. ENTSO-E AISBL. Jan. 2012.

CHAPTER-3.2

Techniques for improving power quality from a topological standpoint: a Review.

Vinita Sirala[1], Deepak Kr. Verma[2]
[1,2]Assistant Professor, JB Institute of Technology, Dehradun, India,248197
vinitasirala@gmail.com

ABSTRACT: *As more sensitive loads are introduced to the utility grid, power quality (PQ) is becoming increasingly important. The general issues associated with PQ problems in industries are product quality degradation, equipment damage, and temporary shutdowns. Any malfunction or damage to industrially sensitive loads results in monetary losses that are disproportionately greater than the severity of the PQ problems. A new concept known as Custom Power System devices CUPS was created to improve the performance of the distribution network. With the introduction of these CUPS, power electronics technology has replaced traditional power quality mitigation methods. DVR and UPQC are two of the most common power electronic controller-based CUPS DVR is a viable solution for the financial losses caused by PQ issues in the workplace. The DVR is the most cost-effective of the CUPS. Only a few papers in the literature correspond to a review of DVR technology. This paper presents a review of the literature on using the Dynamic Voltage Restorer (DVR) to improve power quality. Also in this paper, the various configurations of DVR systems for single phase and three phases are thoroughly discussed. This review aids in the selection of a PQ improvement technique that is technically and economically appropriate for a specific application.*

Keywords- DVR, Power Quality.

INTRODUCTION

Because it determines the advantages in the intensely competitive trade environment, the importance of power quality is something that cannot be compromised between customers and power utility companies. The utility company benefits from the high quality of the power that is delivered to the customer. Electrical and electronic appliances may sustain damage from voltage disturbances and other power quality problems. In order to provide a user with power of a sufficient quality, numerous efforts have been made to ensure that the quality of the voltage magnitude and frequency are within the permissible tolerance. The system has a number of power quality problems, including voltage swelling, sagging, harmonic, and service interruption. Voltage sag and swell are the most serious voltage problems because they have an impact on how well the system's loads function, particularly the more delicate ones. Several techniques have been suggested and put into use in order to lessen the system's impact caused by the voltage and power quality disturbances. To account for the voltage difference between normal and disturbed operating conditions, techniques like D-STATCOM, SST, UPS, and DVR are used. Due to its superior performance compared to other devices, the DVR is regarded as the best option for mitigating voltage sag and swell. In addition, DVR offers a more affordable option than other gadgets . In order to compensate for voltage instabilities that could damage appliances, DVR is frequently installed through a transformer between a network and a sensitive load. This paper presents a review of the

literature on using the Dynamic Voltage Restorer (DVR) to improve power quality. Also in this paper, the various configurations of DVR systems for single phase and three phases are thoroughly discussed. This review aids in the selection of a PQ improvement technique that is technically and economically appropriate for a specific application. A power electronic device called the DVR is used to inject voltage in parallel with a distribution feeder in order to balance out voltage sags and swells. Active and/or reactive power should be added to the distribution feeder in order to restore the load voltage. This essay will discuss various power quality issues and introduce the DVR custom power device for addressing them.

POWER QUALITY

Any power issue that results in voltage, current, or frequency deviations that cause customer equipment to malfunction or fail. There are many different types of power quality issues; each of these issues may have a number of different causes, effects, and solutions that can be used to enhance the power quality and performance of equipment.

Power Quality Issues:

TRANSIENT: A transient is a quick, low-power frequency change in a voltage, current, or both steady-state condition. caused by lightning, turning on or off large machinery, 0.5 back-to-back capacitor energization, and the results of this are Tripping, Processing Error, Loss of Data, and Need for Hardware Reboot component malfunction.

VOLTAGE SAG: A sag is a decrease in rms voltage or current that occurs at the power frequency for periods ranging from 0.5 cycles to 1 minute and is caused by the starting of large motors, the energizing of heavy loads, and improper VAR compensation. faults in the distribution or transmission network. Error, shrinking screens on displays, equipment shutdown, and memory loss are some effects of this.

VOLTAGE SWELL: A swell is defined as an increase in rms voltage or current of between 1.1 and 1.8 pu for periods ranging from 0.5 cycle to 1 minute at the power frequency. Bright lights, data errors, racing or blinking of the digital clock are the results of energising a large capacitor bank, turning off a large load, and incorrect VAR 0.5 compensation.

VOLTAGE INTERRUPTION: An interruption occurs when the supply voltage or load current drops to less than 0.1 pu for a duration of no more than one minute. This can be caused by faults (short circuits), equipment failures, insulator failures, lightning, control malfunctions, and other factors. Device failure, lost programming, computer shutdown, and disc drive failure.

HARMONICS: Harmonics are integral multiples of some fundamental frequency that, when added together, results in a distorted waveform. caused due TO IT equipment, fluorescent lighting and any non-linear load such as variable frequency drives, Electro- Magnetic Interference from appliances, SMPS and effects of this is Line current increases, Higher losses Transformer and neutral conductor overheating, leading to reduced equipment life span, instruments malfunctioning.

Substitutes used for improving power quality: There are numerous available custom power devices, each with their own advantages and limitations: Uninterruptible Power Supply (UPS), Static Electronic Tap Changers (SETC), Solid State Fault Current Limiter (SSFCL), Static VAR Compensator (SVC), Thyristor Switched Capacitors (TSC), Battery Energy Storage Systems (BESS), Distribution Series Capacitors (DSC), Solid-State Transfer Switches (SSTS), Surge Arresters (SA), Super Conducting Magnetic Energy Systems (SMES), Active Power Filters (APF) (DVR). When it comes to reducing the effects of voltage disturbances on sensitive loads, DVR is regarded as an effective and efficient custom power device. Reactive power compensation and harmonic compensation are additional features of DVR.

Dynamic Voltage Restorer (DVR): Dynamic Voltage Restorer (DVR) is a series-connected solid-state device that adds extra voltage to the system to control the load side voltage to the desired magnitude and waveform even when the source voltage is unbalanced or distorted.

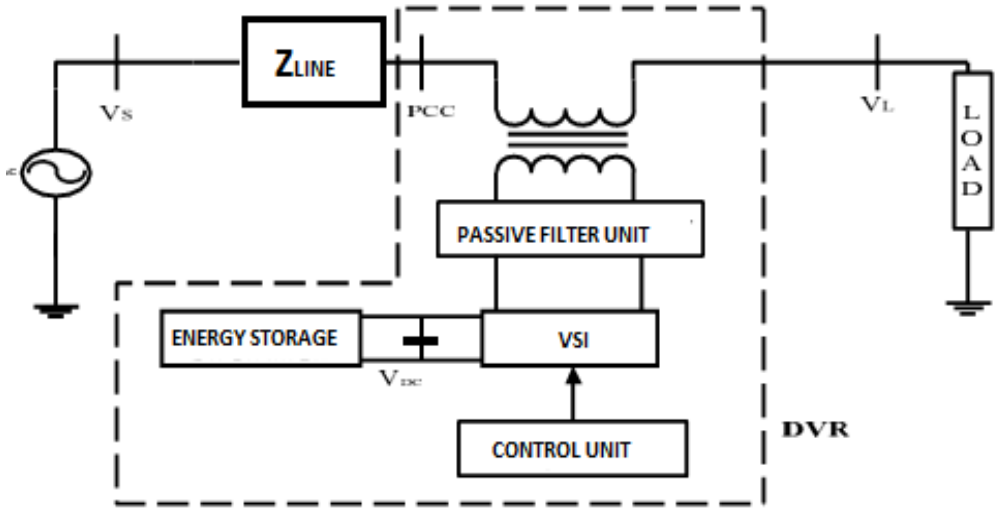


FIG 1: Structure of DVR

$V_{DVR} = V_L + Z_L I_L + V_S$

Where Z_L is the load impedance, I_L is the load current, V_S is the system voltage, and V_L is the desired load voltage magnitude (during faulty condition)

$I_L=(P+jQ)/V_L$

When V_L is considered as a reference equation can be written as

$V_{DVR} \angle\alpha = V_L\angle 0 + Z_L I_L \angle (\beta - \theta) + V_S\angle\delta$

Where α = angle of V_{DVR}, β = angle of Z_L, δ = angle of V_S and θ is load power angle.

The complex power injection of the DVR can be written as

$S_{DVR} = V_{DVR}\, I_L*$

Table 1: The components of the DVR's descriptions

Sr. No.	Component	Description
1	Energy Storage	Supercapacitors, batteries with superconducting magnetic energy storage, lead-acid batteries, and flywheels are a few examples of the types of energy storage that are commonly considered for DVR because they are highly responsive during the charging and discharging process.
2.	VSI	It is necessary for the inverted voltage to be balanced, pure sinusoidal, and timed to the system voltage in order to convert the DC supply from the energy storage to the AC supply of the distribution network.
3	Filter circuit	In order to preserve the integrity of the compensated voltage, it is necessary to filter out any harmonics produced by the VSI.
4	Bypass switch	Upon detecting an excessive current flow, the switch bypasses the current from the DVR circuit to protect it from the overcurrent, preventing high current from passing through the DVR circuit in the event of a system fault.
5	Injection Transformer	Increasing the compensation voltage derived from the VSI's output to match the distribution network's voltage level. It serves as a barrier between the distribution network and the DVR.

TECHNIQUES OF DVR'S VOLTAGE INJECTION/COMPENSATION

Phase angle and magnitude are important factors in controlling a DVR for voltage injection. Three different compensation techniques could be used to provide the necessary voltage supply.

Pre-sag compensation: The pre-sag compensation method used for the DVR application is shown in Figure 2. By restoring the magnitude and phase of the voltage prior to the occurrence of the voltage sag, this method compensates the variance of sagging voltage with pre-sag voltage. The voltage of the system before the disturbance is represented in the figure by Vp-sag. The voltage and phase angle both decreased to Vsag and θsag after the voltage disturbance. This method injects the voltage magnitude VDVR and the phase angle θDVR to the system in order to make up for the system's loss of the Vsag and sag during the disturbance, respectively. Compared to other approaches, this pre-sag compensation method requires a relatively higher magnitude of voltage injection. As a result, when voltage sags, the active power requirement is quite high. This method is typically used with appliances like thyristor-type converters that are sensitive to phase angle shift. This method uses DVR to maintain the load voltage phasor at its pre-disturbance level. For non-linear loads that are susceptible to phase angle jumps, this compensation strategy is advised. Both the voltage sag and the phase jump are restored. At the load side, it prevents any circulating or transient current. During compensation, it requires active power.

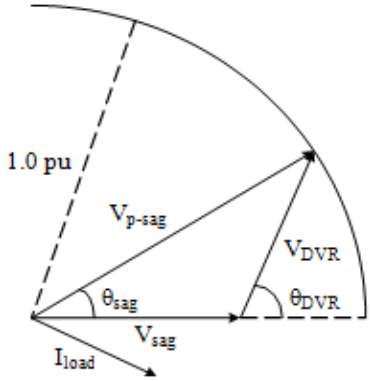


FIG 2: Pre-sag compensation technique

In-phase Compensation: The DVR's in-phase voltage compensation method is depicted in Figure 3. In contrast to the previous method, the DVR in this one injects the voltage magnitude VDVR without compensating for the phase angle θDVR. This method only makes up for the decreased voltage magnitude. As a result, it is appropriate for linear loads that don't need phase angle compensation. The method supplies the load with the lost voltage magnitude VDVR when the magnitude of the voltage supply decreases as a result of the voltage disturbance.

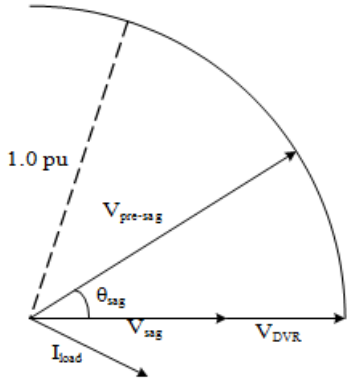


FIG 3: In-phase Compensation technique

In-phase advanced or Minimum Energy compensation technique: The minimum energy compensation method of a DVR is represented by the magnitude and angle representation in Fig 4. The method injects the required voltage magnitude VDVR with a 90° phase angle to the load based on the diagram. Following a voltage disturbance in the system, the system voltage Vpre-sag∠θpre-sag falls to the Vsag∠0°. After detecting the voltage disturbance, the DVR raises the voltage to Vcomp and injects the required VDVR 90° into the system. Although the method does not involve actively injecting power into the system, the injected voltage may necessitate the use of a transformer and inverter with a higher rating in order to balance out the voltage disturbance in the system. As shown in the figure, the VDVR required for the pre-sag and in-phase compensation methods shown in Figures 2 and 3, respectively, is relatively higher than the VDVR shown in Figure 4. This method advances the voltage so that the line current and injected voltage phasor are parallel. The capacity of the energy storage device may become a limiting factor in the compensation in cases of pre-

sag and In-phase where the DVR is required to insert real power into the defective line during the compensation period. The DC link, one of the most expensive components of the DVR, is where the real power is stored. The fundamental goal of energy optimization method is to make the injection voltage phasor perpendicular to the load current phasor, which will result in zero injection real power component. With this method, the system's load current and voltage values are fixed, allowing us to change only the phase of the sag voltage. Reactive power is only used during compensation, and since it is electronically produced by the voltage source inverter (VSI), a higher VSI rating is needed.

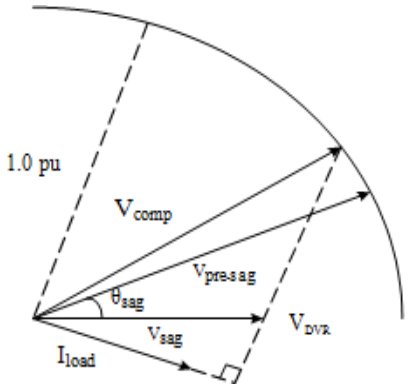


FIG 4. In-phase advanced or Minimum energy compensation

TYPES OF DVR CONTROL STRATEGIES

The active and reactive power control strategies used by a DVR to mitigate system power quality issues are crucial to the device's operation. The VSI is the primary target of the DVR's control strategies. Numerous VSI control strategies have been reported in the literature. The linear and non-linear control subcategories of the DVR's control strategies are distinguished in this paper. The type and sensitivity of the load in the system determines how the DVR control strategies are taken into account.

Linear Control Strategy: The linear Control strategy also known as conventional control method they are basically of three type feedforward, feedback, and hybrid. The most popular technique used in DVR is feedforward control. By measuring the difference between the system's pre-sage and real-time voltage using an open-loop system, the method reduces the impact of the power quality issue. The method is well-liked because it is straightforward, inexpensive, and quick even though it is not as accurate as other control methods. Therefore, less sensitive and less critical load mitigation is preferred over other, more sophisticated methods. By comparing the load voltage to the reference voltage, the feedback method adopts a closed-loop control strategy. In terms of accuracy in power quality mitigation, the method performs better than the feed-forward method. The method, however, is more intricate and takes longer to deliver the required control response. The hybrid control method, on the other hand, combines the benefits of both feed-forward and feedback control strategies. The simplicity and cost of the controller are sacrificed in favour of the composite control method's improved accuracy of power quality compensation.

Table 2: Comparison of linear controllers

Parameters	Feed-forward	Feedback	Hybrid
Measures	Grid Voltage	Load Voltage	Combination of both
Time Response	fast	medium	It has strength of feed-forward and feedback both.
E_{ss}	high	Can eliminated	
stability	good	Not good	
Switching harmonic	Doesn't enter control	Enter control	
Compensation of Asymmetrical. fault	slow	good	

Non-linear control: Because of the power semiconductor switches in the inverter circuit, the DVR is a non-linear device. Given that the DVR is a non-linear system, it would seem that the nonlinear controller would be more appropriate than the linear type. The operating range in which linear control is effective is finite. Typically, a traditional controller has only covered a small portion of DVR applications.

The DVR's linear control cannot keep up with the constantly changing operating conditions at higher levels of the distribution network. The nonlinear control is therefore thought to deal with this problem. As a result, a number of non-linear control methodologies for the DVR are reported in the literature that make use of artificial neural networks (ANN), fuzzy logic, and space vector pulse width modulation (SVPWM).

In order to effectively solve a complex engineering problem, ANN is currently being considered in all engineering topics. The primary advantage of this method is its capacity to mimic human or complex system decision-making. For the nonlinear control of the DVR application, several studies have been reported that use ANN.

Fuzzy Logic (FL): In cases where precise mathematical formulations are not practical, Fuzzy Logic controllers are a desirable alternative. It can be used to significantly reduce PWM's tracking error and transient overshoots. The FL controller's properties, however, are extremely vulnerable to overlapping and changing fuzzy set shapes.

Space vector pulse width modulation (SVPWM): In SVPWM, we substitute the original Sinusoidal PWM with a voltage inverter space vector of the switch to obtain a quasi-circular rotating magnetic field, improving switch over performance under low switching frequency conditions.

The SVPWM technique is one of the most sophisticated and computationally intensive PWM techniques available today. SVPWM is employed due to its simpler implementation and improved dc bus utilisation. SVPWM is used to reduce the DVR's performance's dependence on the load voltage's negative sequence component.

Artificial Neural Networks (ANN): The ANN's adaptive and self-organizing capabilities enable it to provide increased interpolation precision. Without a mathematical model, it can establish a nonlinear relationship based on input and output. The performance of ANN varies with the number of training data and the structure of the neural network considered. Unlike

the ANN, the fuzzy logic controller has proved itself in replacing the conventional controller in practice.

CONCLUSION

A brief literature review on DVR configurations and its control strategies is conducted in this paper. Different power quality issues, such as voltage harmonics and voltage sag/swell compensation, can be solved by choosing any one of them. Energy conservation, fewer parts and losses, minimal power injection, reduced rating, and mitigation of specific harmonics must all be prioritised in order to enhance DVR performance.

REFERENCES

[1] D. Amalorpavaraj, R. A. J., Palanisamy, K., Umashankar, S., & Thirumoorthy, “Power quality improvement of grid connected wind farms through voltage restoration using dynamic voltage restorer,” Int. J. Renew. Energy Res., vol. 6, no. 1, pp. 53–60, 2016.

[2] F. Zobaa and S. H. E. Abdel Aleem, “A new approach for harmonic distortion minimization in power systems supplying nonlinear loads,” IEEE Trans. Ind. Informatics, vol. 10, no. 2, pp. 1401–1412, 2014.

[3] Rini Ann Jerin, N. Prabaharan, K. Palanisamy, and S. Umashankar, “FRT Capability in DFIG based Wind Turbines using DVR with Combined Feed-Forward and Feed-Back Control,” in Energy Procedia, 2020, vol. 138, pp. 1184–1189.

[4] Babaei, E.; Kangarlu, M.F., "Voltage quality improvement by a dynamic voltage restorer based on a direct three-phase converter with fictitious DC link," Generation, Transmission & Distribution, IET , vol.5, no.8, pp.814-823, August 2011.

[5] N.-M. Ho and H. S.-H. Chung, “Implementation and Performance Evaluation of a Fast Dynamic Control Scheme for Capacitor-Supported Interline DVR,” IEEE Trans. Power Electron., vol. 25, no. 8, pp. 1975–1988, 2010.

[6] Divyalakshmi and N. P. Subramaniam, “Photovoltaic based DVR with Power Quality Detection using Wavelet Transform,” in Energy Procedia, 2017, vol. 117, pp. 458–465.

[7] N. Katole, M. B. Daigavane, S. P. Gawande, and P. M. Daigavane, “Analysis, Design and Implementation of Single Phase SRF Controller for Dynamic Voltage Restorer under Distorted Supply Condition,” in Energy Procedia, 2017, vol. 117, pp. 716–723.

[8] Elserougi, A.; Abdel-Khalik, A.S.; Ahmed, S.; Massoud, A., "Active and reactive power management of photovoltaic-based interline dynamic voltage restorer in low voltage distribution networks," Energy Conversion Congress and Exposition (ECCE), 2012 IEEE , vol., no., pp.3098,3104, 15-20 Sept. 2012.

[9] H. Gandoman, A. Ahmadi, A. M. Sharaf, P. Siano, J. Pou, B. Hredzak, and V. G. Agelidis, ‘‘Review of FACTS technologies and applications for power quality in smart grids with renewable energy sys tems,’’ Renew. Sustain. Energy Rev., vol. 82, pp. 502–514, Feb. 2018.

[10] J. Li, X. P. Zhang, S. S. Choi, T. T. Lie, and Y. Z. Sun, “Control strategy for dynamic voltage restorers to achieve minimum power injection without introducing sudden phase shift,” IET Gener. Transm. Distrib., vol. 1, no. 5, p. 847, 2007.

[11] K. Yada, “Operation and Control of Single-Phase UPQC based on SOGI-PLL,” 2016 IEEE Int. Conf. Power Electron. Drives Energy Syst., pp. 1–5, 2016.

[12] K. Yada and A. S. Kumar, “An SO-SOGI based control for a three-phase DVR under distorted grid conditions including DC offset,” in IEEE Region 10 Annual International Conference, Proceedings/TENCON, 2017, vol. 2017-Decem, pp. 3000–3005.

[13] Hossam-Eldin, A.; Elserougi, A., "Renewable energy fed interline DVR for voltage sag mitigation in distribution grids," Electricity Distribution (CIRED 2013), 22nd International Conference and Exhibition on, vol., no., pp.1,4, 10-13 June 2013.

[14] K. Ç. Bayindir, A. Teke, and M. Tümay, “A robust control of dynamic voltage restorer using fuzzy logic,” in International Aegean Conference on Electrical Machines and Power Electronics and Electromotion ACEMP’07 and Electromotion’07 Joint Conference, 2007, pp. 55–60.

[15] Li, B.H.; Choi, S.S.; Vilathgamuwa, D.M., "Transformerless dynamic voltage restorer," Generation, Transmission and Distribution, IEE Proceedings- , vol.149, no.3, pp.263-273, May 2020.

[16] M. C. Jiang and K. Y. Lu, “Analysis & design of a novel soft-switching single-phase dynamic voltage restorer,” in Proceedings of the 2017 IEEE International Conference on Applied System Innovation: Applied System Innovation for Modern Technology, ICASI 2017, 2017, pp. 861–864.

[17] M. S. Kasyap, A. Karthikeyan, B. V. Perumal, and C. Nagamani, “An effective reference generation and control of DVR using DSOGI-prefilter based PLL,” in Proceedings of IEEE International Conference on Circuit, Power and Computing Technologies, ICCPCT 2016, 2016, pp. 1–7.

[18] M. S. Kasyap, A. Karthikeyan, B. V. Perumal, and C. Nagamani, “DSC filter based unit vector estimator for reference generation and control of dynamic voltage restorer,” in 2016 IEEE 7th Power India International Conference, PIICON 2016, 2017, pp. 1–6.

[19] Naeem Abas, Saad Dilshad, Adnan Khalid, Muhammad Shoaib Saleem, Nasrullah Khan. "Power Quality Improvement Using Dynamic Voltage Restorer" , IEEE Access, 2020.

[20] R.A.J. Amalorpavaraj, P. Kaliannan, S. Padmanaban, U. Subramaniam, and V. K. Ramachandaramurthy, “Improved fault ride through capability in DFIG based wind turbines using dynamic voltage restorer with combined feed-forward and feed-back control,” IEEE Access, vol. 5, pp. 20494–20503, 2017.

[21] S. Ali, Y. K. Chauhan, and B. Kumar, “Study & performance of DVR for voltage quality enhancement,” in 2013 International Conference on Energy Efficient Technologies for Sustainability, ICEETS 2013, 2013, pp. 983–988.

[22] Sng, E.K.K.; Choi, S.S.; Vilathgamuwa, D.M., "Analysis of series compensation and DC-link voltage controls of a transformerless self-charging dynamic voltage restorer," Power Delivery, IEEE Transactions on , vol.19, no.3, pp.1511-1518, July 2004.

[23] Usha, R. P., R. Sudha, and S. Rama Reddy. "Voltage sag/swell compensation in an interline dynamic voltage restorer." In Emerging Trends in Electrical and Computer Technology (ICETECT), 2011 International Conference on, pp. 309-314. IEEE, 2011.

[24] Vilathgamuwa, D.M.; Wijekoon, H.M.; Choi, S.S., "Interline dynamic voltage restorer: a novel and economical approach for multiline power quality compensation," Industry Applications, IEEE Transactions on, vol.40, no.6, p.1678,-685, Nov.-Dec. 2020

CHAPTER-3.3

Modern Studies on Solar Energy Wireless Charging of Electric Vehicles

Vinita Sirala[1], Deepak Kr. Verma[2]
[1,2]Assistant Professor, JB Institute of Technology Dehradun, Dehradun, India, 248197
vinitasirala@gmail.com

ABSTRACT: *Within the past decade, since impediments in nonrenewable fuel sources and the contamination they cause, utilizing green energies, such as those that are sun-oriented, in tandem with electric vehicles, is a developing slant. Coordinating electric vehicle (EV) charging stations with sunpowered boards (PV) reduces the burden of EV charging on the control framework. This paper presents a state-of-the-art literature review on remote control transmission frameworks for charging the batteries of electric vehicles utilizing sun-based boards as a source of power generation. The goal of this research is to advance knowledge in the wireless power transfer (WPT) framework and explore more about solar-powered electric vehicle charging stations. To do this, a variety of solar-powered electric vehicle charging station types are thoroughly studied. Following a study of many framework elements, the types of WPT components are explored in a different section. Within the wireless power transmission framework for solar-powered electric vehicle charging, compensators and various coil structures are also investigated, along with the advantages of each coil over the others. This study also discusses the use of artificial intelligence (AI) in WPT frameworks and highlights the important aspects of developing an AI model.*

Keywords: wireless power transmission; electric vehicle charging; photovoltaic system; artificial intelligence; solar energy

INTRODUCTION

Due to the growing demand of consumers worldwide, the need for electricity generation has increased [**1**]. At the same time, rising natural gas prices and regulatory emphasis on limiting greenhouse gas emissions have increased the cost of generating electricity using fossil fuels [**2**]. Because of this, there has been an increase in the usage of alternative energy sources for providing electricity, such as the solar power produced by solar systems. Utilizing EVs is another action to take to reduce air pollution. However, it needs to be considered that they only go a short distance on a single charge. Electric vehicles require charging stations for their batteries, as was previously mentioned. The most common and secure method of charging an electric vehicle is with a wire connected to the grid; however, the focus of this article is on the use of renewable energy sources, such as solar power, as a power generation source for wireless power transfer (WPT) technology. To avoid the drawbacks of using cables for charging, WPT can also be employed [**3**,**4**]. The structure of the charging stations, as well as their problems and potential solutions, are discussed in the following.

Fig. 1 illustrates the general state of charge of an electric car wirelessly using a photovoltaic panel [**2**]. Solar cells and the controller section are two of the most crucial parts of the charging station. It is not feasible to obtain the maximum power from the solar panels at the output, due to weather conditions, shadows, the location of the sun according to the solar

panel, and other variables. However, we can obtain and transmit the maximum power from the solar cells to the output by using maximum power point tracking (MPPT) algorithms.

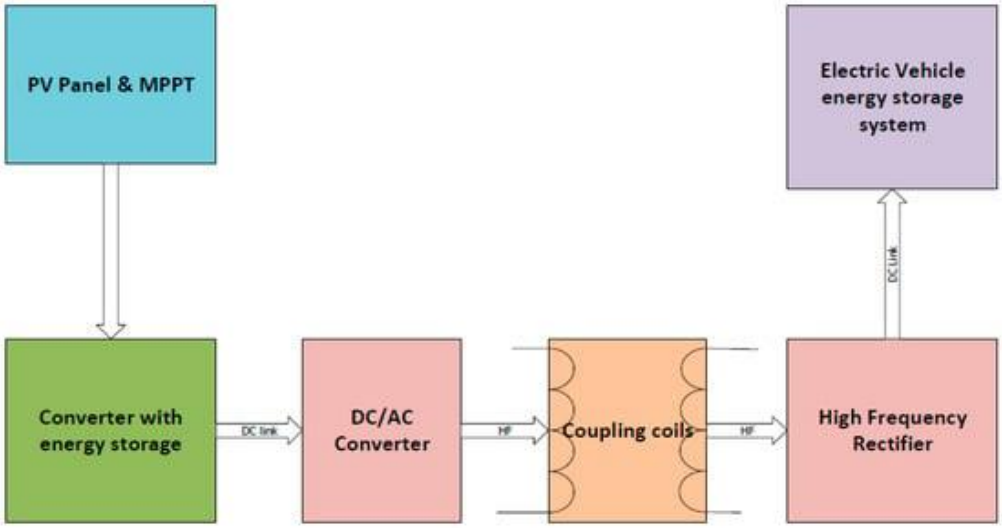


Figure 1. Overview of wireless charging powered by a solar panel.

The Perturb and Observation (P&O) method, which compares the voltage and current in every moment and the moment before and chooses the optimal value, is one of the most common and straightforward approaches in this subject. Another important component is converters, which can change the voltage level to the desired value. It falls into two broad groups, DC–DC and DC–AC converters, both of which are important. The best and most widely used converter is the buck/boost converter.

As previously mentioned, the losses that impact the system's efficiency are the main problem with power transmission; hence, several resonates are utilized to create resonances, and the best of them is LCC resonance. Using various coil structures—which can be referred to as a circular structure, instead of the standard ones—is another technique to increase system efficiency, and after performing the above process, we can raise efficiency up to 90%. After transferring power to the secondary coil, an alternative voltage, that is, DC, is required. To accomplish this task, due to the high-frequency system, a high-frequency rectifier is required. Next, the voltage must be changed to a suitable voltage for the energy storage used in EVs. For EVs, lithium-ion (Li-ion) is frequently used, as it has a higher power density than lead-acid or nickel-cadmium rechargeable batteries. A DC–DC converter can be employed to do that. We can then wirelessly charge EVs using a solar panel after completing this method. Solar energy and electric cars may be utilized to minimize air pollution, which is a highly serious issue in recent years, owing to air pollution and the limited supply of fossil fuels [**5**]. Additionally, due to their limitations in storing energy and traveling short distances, electric vehicles need charging stations to be able to provide the energy required for electric vehicles to travel long distances. There are many ways to charge an electric vehicle, known as AC and DC charging modes [**6**]. **Table 1** summarizes the types of charges available for electric vehicles. Since there are several sorts, each of which needs cables and unique converter heads

to charge, technology has advanced to the point where it is now possible to transmit electricity wirelessly, as is covered below.

Table 1. Electrical quantities and types of charging methods [**7**].

Here, the induction wireless power transmission mode—which has issues, such as power losses—is investigated for charging all-electric vehicles, in order to do away with various types of cables and unique converter heads. The properties of various resonants are holistically discussed in [**4**], and for gaining the maximum power output from the solar panel, MPPT is employed (one of the simple and efficient method is P&O [**8**]).

1. This article focuses on analyzing the methods and techniques required to wirelessly transmit power for electrical cars that use solar energy as a clean energy source. The objectives of the research are as follows:
2. The article begins with a discussion of photovoltaic systems, looking at grid-connected and off-grid options, and then looking at maximum power point tracking to maximize the amount of electricity generated by solar panels. This study also investigates energy storage to determine the best type of storage to save energy and minimize losses.
3. The study will explore several wireless power transmission techniques, including static and dynamic stations, to identify the distinctions and benefits of each station.
4. The paper will discuss coil structures to take into account the optimal and efficient structure for coils to prevent power loss, as well as to maintain safety due to magnetic waves, which are harmful to people. By reviewing these structures, the paper hopes to increase the efficiency and reliability of power transmission.
5. The evaluation of artificial intelligence applications used in WPT, whose primary objectives are to speed up computation, identify faults, and improve efficiency, is the last target of this article.

The architecture of the paper is organized as follows: **Section 1** represents an introduction of wireless charging for electric vehicles utilizing solar cells. **Section 2** discusses the fundamentals of the photovoltaic system and its components, as well as the various types of electric vehicles. The types of wireless power transmission, types of coil topologies, and their outcomes will all be covered in this section, as well. **Section 3** will describe the use of

artificial intelligence in WPT systems, along with the key factors that go into creating an AI model. We will review, wrap up, and make suggestions for further research in the fourth session. The final section will present the conclusion.

2. Wireless Charging Station for Electric Cars Using Solar Energy

In general, all types of charging stations will be divided into two distinct categories: static and dynamic. However, first, a look at solar systems is had before discussing different kinds of charging stations.

2.1. The Solar Power Generation System: According to **Figure 2**, a solar system has three primary components, and an energy storage system would make it four if we included it:

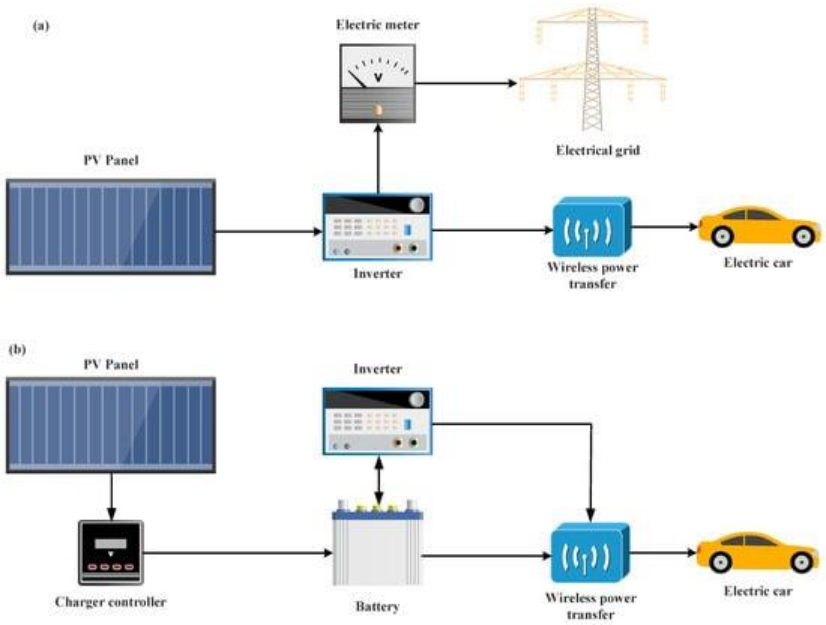


Figure 2. Overview of a grid-connected photovoltaic system (**a**) and off-grid system (**b**).

- Photovoltaic array;
- DC–DC converters;
- MPPT system;
- Energy storage system.

2.1.1. Photovoltaic Systems: The phenomenon by which the radiant energy of the sun is converted into electricity without the use of mechanical mechanisms is called the photovoltaic phenomenon. In general, photovoltaic systems are classified into two groups, according to their application: grid-connected units and off-grid units.

Photovoltaic Systems Connected to the Grid: In a grid-connected system, electricity generated from solar energy will be injected into the national grid. Photovoltaic systems connected to the national grid are centralized or decentralized to strengthen the national grid and prevent electrical pressure on power plants during the day, and more details about PV market could be found in [**9**]. The advantages of this system include easy installation and setup, high efficiency, and no need for complex peripherals. **Figure 2**a shows a grid-

connected photovoltaic system. Typically, this system does not require a battery to store electrical energy, but sometimes, energy storage devices, such as batteries, are utilized to improve network reliability. Therefore, the grid-connected systems of global electricity can be classified into two groups, with a storage system and without a storage system [**10**].

Grid-Independent Photovoltaic System: The off-grid system is illustrated in **Figure 2**b. In unfavorable weather conditions, it is necessary (or required) for the energy storage system to be able to feed the entire load of the system for several days. These devices are typically utilized in places where there is no access to the national power grid or where it is expensive to connect. For example, in mountainous telecommunication bases, nomadic areas, rural cottages, and to meet the electrical needs of areas that do not have a national electricity grid in general, a grid-independent photovoltaic system can be used [**11**]. The conceptual foundation and environmental impact of PV systems are covered in further depth in [**12**,**13**].

2.1.2. DC–DC Converter: Converters play a major role in the photovoltaic system, which is responsible for changing the voltage and current to the expected value. DC–DC converters can be divided into two types of reducers and boosters [**14**]. The aid commands the switches to turn on and off, and the circuit operates to reach the expected voltage level. **Figure 3** represents the electrical circuit of the buck converter:

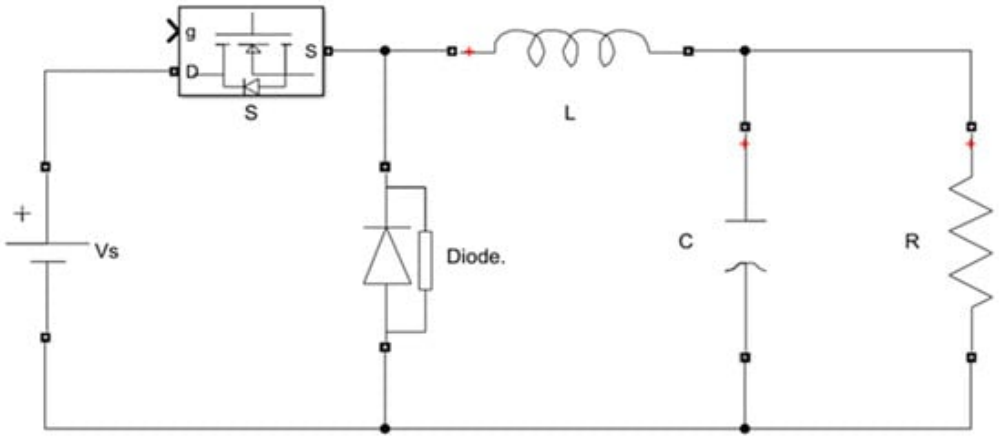


Figure 3. Buck converter circuit.

As mentioned in **Figure 3**, the circuit has a duty cycle that is obtained from the following equation:

$$D=TonToff=VOVin\text{}=\text{}=\text{} \quad (1)$$

in which Ton is the time for the switch to be on, $Toff$ is the time for the switch to be off, VO is the output voltage, and Vin is the input voltage.

2.1.3. Maximum Power Point Tracking Methods: The non-linearity of the solar cell output characteristic, as well as the fluctuation of light radiation and even cell temperature, are some of the problems that hinder solar panels from operating at their maximum power point. As a result, a system for controlling solar cells must be taken into consideration. This system should not only position the solar cell at its best working point but should also be able to

continuously track the maximum point of the system's maximum transmission power in the event that this point changes due to the weather conditions and position the solar cell there. This type of continuous following is called the maximum transmission power. The task of the MPPT algorithm is to find the actual maximum power point and track it. It should be noted that, in some cases, especially in conditions of non-uniform radiation, several local maximum points may occur; but there is only one real maximum point. Different ways have been suggested to pursue maximum power [**15**]. There are two types of algorithms for MPPT, conventional and intelligent. One of the most widely used conventional methods that has been considered in this research is the perturbation and observation method, and one of the intelligent algorithms of MPPT is fussy logic [**16**].

Perturbation and Observation Method (P&O): The basis of this algorithm is to create a disturbance in the operating cycle of the electronic converter of power and consideration and its effect on the output voltage of the array (PV) (**Figure 4**). Disturbance in the power cycle of the electronic power converter will lead to disturbance in the current of the PV array and, consequently, the disturbance of the voltage of the solar array.

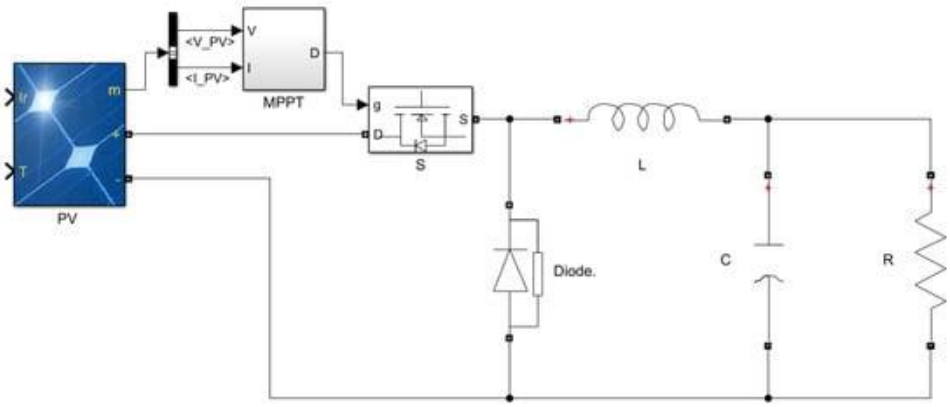


Figure 4. Perturb and observation control system.

If we are on the left side of the MPPT, increasing the voltage causes an increase in power, and vice versa, if we are on the right side, increasing the voltage causes a decrease in power (**Table 2**).

Table 2. Performance of P&O control method [**17**].

According to the table, and according to this algorithm, if an increase in power is observed, the perturbation should stick in this path to reach MPP, and if the power falls, the perturbation should be in the opposite direction. This process should be repeated over and over until we reach MPP [**18**]. One of the problems with the P&O algorithm is that it does not

perform well in the face of rapid climate change. This is shown in **Figure 5**. In constant weather conditions, changes A in PV voltage, move the working point to B, and due to the fall in power, the disturbance signal is reversed. In this case, the radiation level is increased, and the curve is transferred from P_1 to P_2 in the same time interval. The working point is shifted from A to C, an increase in power is observed, and the perturbation continues in this direction. Therefore, the working point moves far away from the MPP point, and if the radiation level increases, the algorithm diverges [**19**].

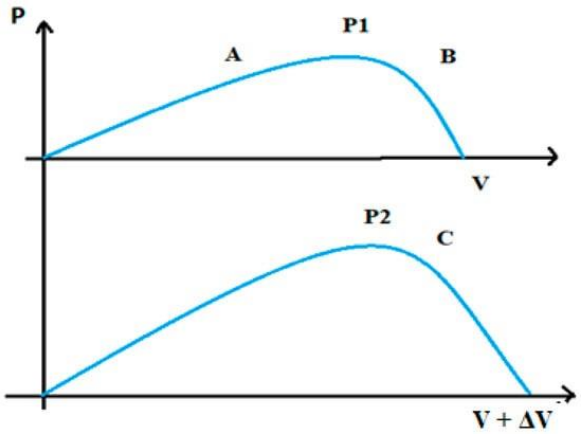


Figure 5. Performance of the P&O method in the face of climate change.

However, the P&O algorithm to extract the maximum output power of the solar panel might be a significant and effective method, among the numerous methods of maximum power tracking, due to its simple algorithm, high reliability, and quick tracking [**20**]. For a better understanding of the P&O method, the flowchart of this method is shown in **Figure 6.**

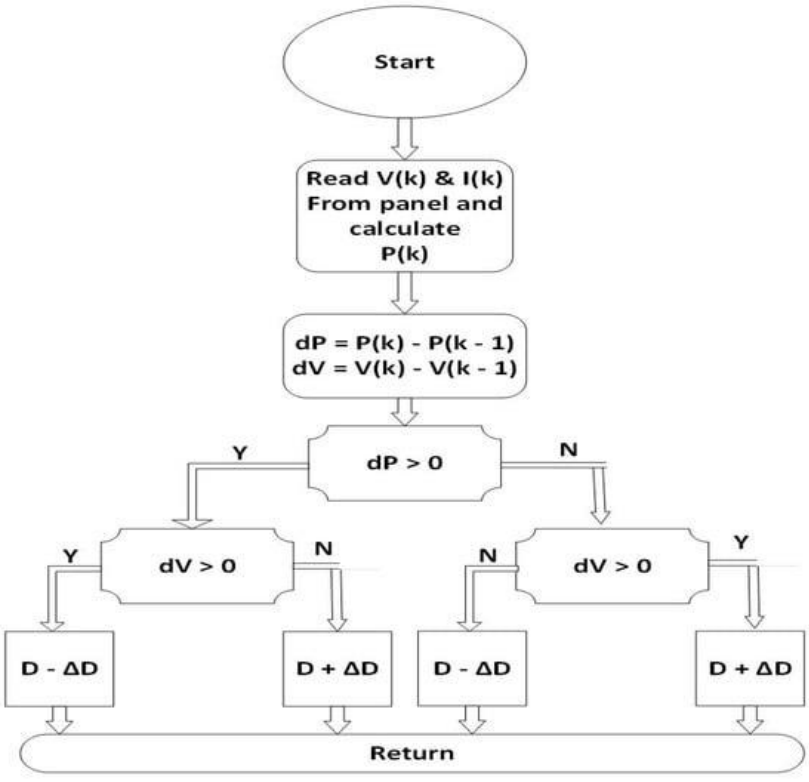


Figure 6. Perturbation and observation method algorithm.

Fussy Logic (FL): Using FL for MPPT prepares several benefits. A number of them are to track the MPP with high precision, not be influenced by disruption of the inputs, and work independently and unpredictably [**21**,**22**]. The FL algorithm includes three steps. In the first step, fuzzification, numerical data are converted into linguistic values with the help of the membership function. There are five levels: Z (zero), NS (negative small), PS (positive small), NB (negative big), and PB (positive big) [**23**]. The FL method inputs generally contain functions that express the error (E) and change in error (ΔE); questions are given below:

$$E=Ppv(t)-Ppv\ (t-1)Vvp(t)-Vvp(t-1)\text{}=\text{}(\text{})-\text{}\ (\text{}-1)\text{}(\text{})-\text{}(\text{}-1)$$

(2)

$$\Delta E(t)=E(t)-E(t-1)\text{}(\text{})=\text{}(\text{})-\text{}(\text{}-1)$$

(3)

where Ppv is the output power of the PV panel, Vvp is the voltage of the photovoltaic panel, E is the error, ΔE is the error difference, and t is time.

In the second step, the rule table, inputs are processed and a decision is made. In the last stage, defuzzification, linguistic data is converted to clear data [**24**].

2.1.4. Energy Storage: Storages may be utilized as a component of a photovoltaic system to supplement solar energy during times of low solar output or at night. Storages are also used as batteries in electric vehicles to power the car. There are different types of storage devices, which we see in **Figure 7**, comparing the life and efficiency of storage devices [**25**].

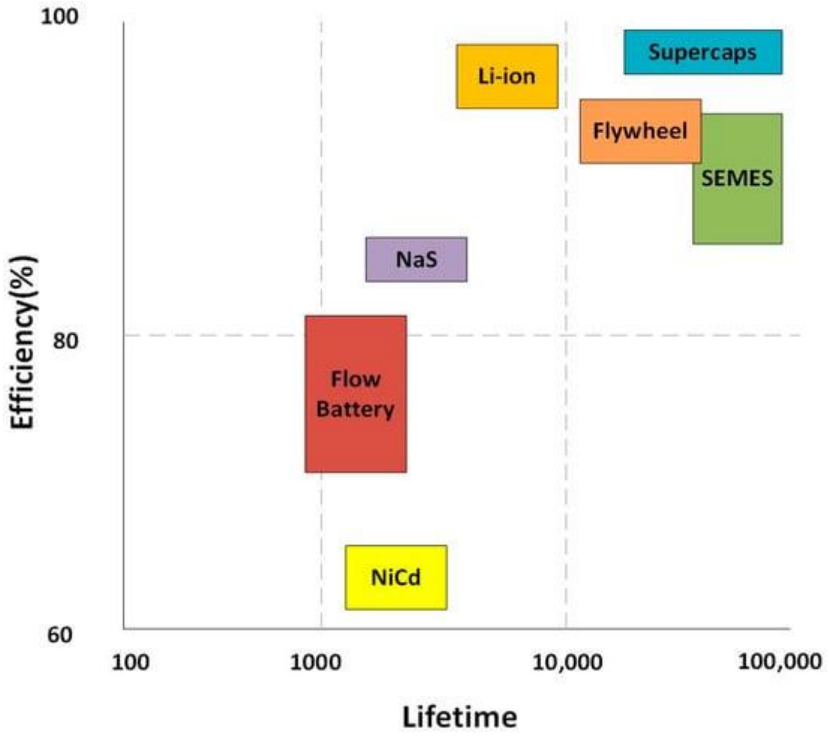


Figure 7. Types of storage devices according to operating time and efficiency [**25**].

As can be seen, the best types of energy storage are lithium-ion batteries and supercapacitors, which have been used recently in [**26**] and [**27**]. Lithium-ion batteries, as one of the storage unit types, are usually employed in electric vehicles as energy storage and power supply, which have advantages such as low volume, high durability, and good efficiency.

2.2. Wireless Electric Vehicle Charging Systems

2.2.1. Static: The static wireless electric vehicle charging systems (WEVCS) initial arrangement is represented in **Figure 8**. Additional power converters and circuits are installed together with the primary winding beneath a road. Typically, the secondary coil or receiving coil is positioned underneath the EVs, either in the front, back, or center. The received electricity is converted from AC to DC using a high-frequency rectifier and transferred to the battery bank. Due to some safety issues, the controller and battery management systems are employed to get feedback from the system. The amount of power coming from the source, the size of the charging pad, and the space between the two coils all affect how long it takes to charge. We can install static-WEVCS in parking's, garages, homes, commercial buildings, and shopping centers, with an average distance of around 150 to 300 mm between light electric vehicles [**28**,**29**,**30**,**31**]. This kind of wireless charging station is seen in **Figure 8**; a solar power plant has been set up nearby that uses MPPT technology to boost power output. Because the energy generated by solar panels is DC, it must be converted to AC for wireless power transmission. A converter is needed to change the system's electricity from DC to AC, so that the car can be charged. The output of this converter is given to a compensator to increase efficiency. Another compensator is placed in the receiver coil. A compensator is employed to minimize the phase between the voltage and current, as well as to minimize the reactive power in the system [**4**,**32**]. In fact, a compensator is needed to increase the efficiency and useful transmission power [**33**]. In addition, a rectifier converter is placed to convert AC to DC electricity to charge the electric vehicle battery (recent developments with rectifiers can be found in [**33**]).

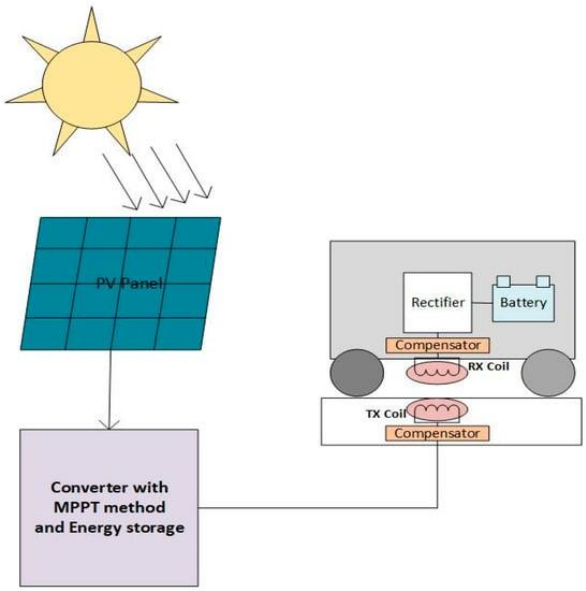


Figure 8. Static wireless electric vehicle charging system schematic.

2.2.2. Dynamic: Plug-in or battery electric vehicles (BEVs) suffer from two major problems—cost and range. To increase the range of distance with fully charged electric vehicles, they must be charged continuously or often need to install a larger storage unit (which leads to additional problems such as cost and weight). Additionally, a common charging method for EVs is not cost-efficient; so, for the problem, we can use a dynamic wireless charging system for electric vehicles (D-WEVCS), which is known as an "electric road". Research shows that this method can reduce the problem range and cost of electric vehicles. Primary coils are positioned and spaced in the road with a high voltage, high frequency AC source, and compensation circuits to the microgrid and/or renewable energy system (RES). The secondary coil similar to static-WEVCS is located below the car and is used to receive the magnetic field generated when electric vehicles (EVs) pass the transmitter. Then, the magnetic field is converted to the DC charge by the power converter BMS. The Possibility of frequent charging of electric vehicles reduces the storage unit size; the need is almost 20%, compared to the current EVs [**32**]. The dynamic wireless charging station system is similar to the static one, with the difference being that the number of transmitter coils is usually more than in the static mode. Therefore, all of the static charging station system's stages apply to the dynamic station, as well. A dynamic wireless charging station for electric cars using solar panels is shown in **Figure 9**.

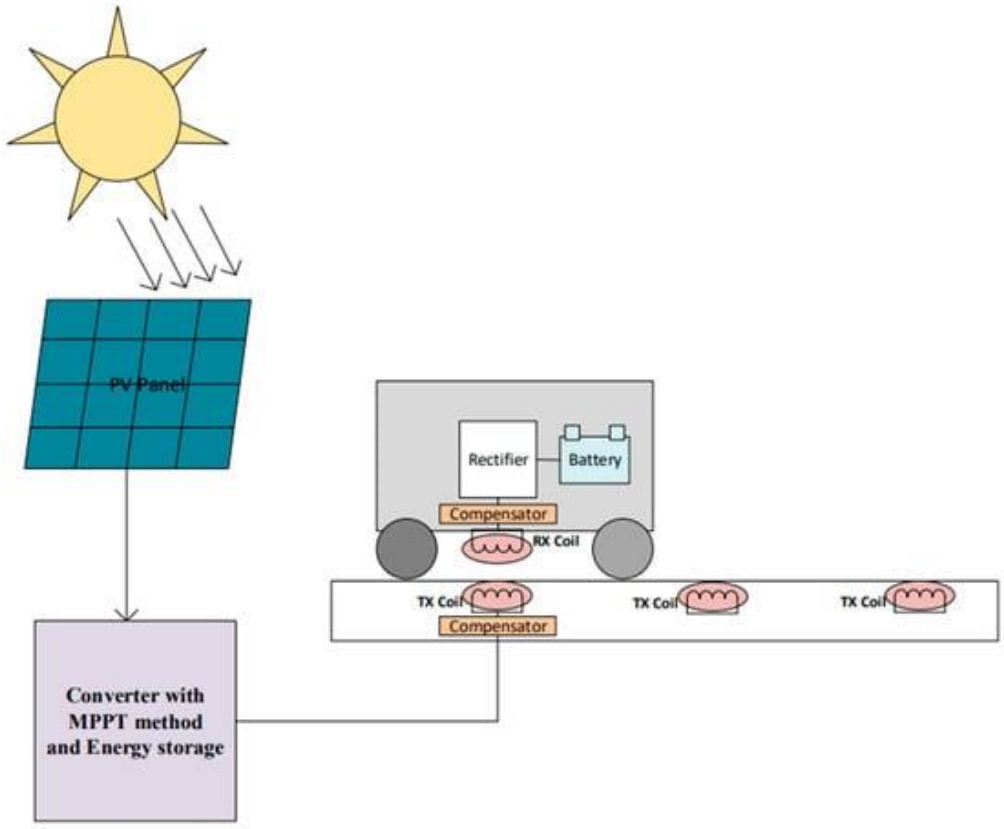


Figure 9. Basic diagram of dynamic wireless electric vehicle charging system.

2.3. Electric Vehicle Connection Type to Grid Models: Electric vehicles can be divided into different modes when connected to the charging network, as follows: Grid to vehicle connection mode (G2V); Vehicle to grid connection mode (V2G).

With the increase of electric vehicles and their batteries, we need to charge them, and because of that, the extra load is added to the distribution network. The distribution network will suffer if this load imposition happens during peak hours, leading to higher losses and voltage decreases [**34**]. Additionally, by developing smart grids with online control, the two-way power exchange capability of electric vehicles, and especially the V2G discharge capability of vehicles, can be used. G2V is also used when solar energy is low and the number of cars to charge is high [**35**], as shown in **Figure 10**.

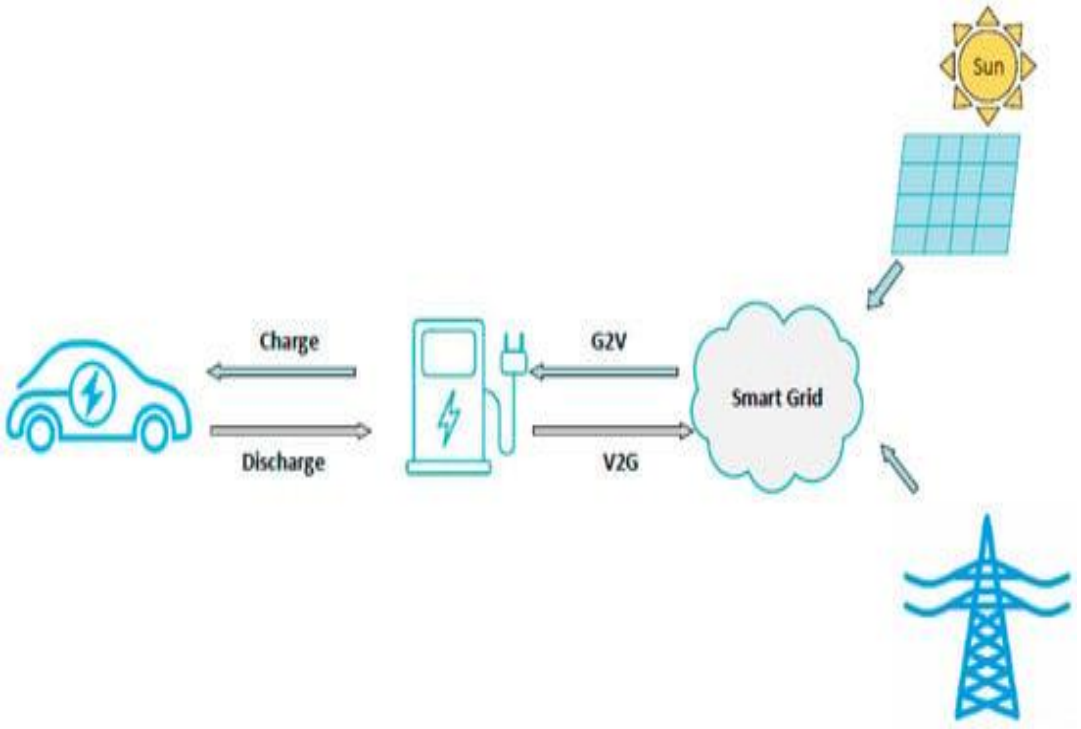


Figure 10. Figure Car connection to the network and vice versa.

2.4. Wireless Power Transmission: Wireless power transmission (WPT) is used for this purpose. Here, we examined different coil structures, such as circular structure and DD, as well as DDQ, which are proposed by researchers at Auckland University [**35**], in which the DDQ structure has shown better performance than other structures. We also list the compensators and compare them to determine which one is the best; the SS compensator performed well, while simplicity was taken into consideration. There are different ways to transmit wireless power, which can be transmitted by radio waves or electromagnetic waves. The focus on electromagnetic waves for wireless power transfer changed as electromagnetism science developed and radio waves were found to be feeble.

Later, with the advancement of science in the field of power transmission, they tried to reduce the dimensions and safety more. They also tried to reduce losses at short distances. Resonance induction is the most popular method for wireless power transmission at short distances nowadays. It was developed by MIT University in 2007 and was designed to enhance the effective distance of power transmission and increase efficiency [**36**]. As of now, their thoughts are focused on minimizing power losses and boosting the transmission power under consideration.

British scientist Michael Faraday contributed to advance the electromagnetic field by creating Faraday's law of induction. This rule outlines the process through which electromagnetic induction or EMFs are produced. The so-called electromagnetic force voltage (V_{emf}), as stated in Equation (4), is created by varying the flux by the temporal change multiplied by the quantity of windings in the coil.

$$Vemf=-Nd\varphi mdt\text{}=-\text{}$$

(4)

where N is the number of turns of the coil, and $d\varphi_m$ is the change in magnetic flux [**37**]. Wireless power transmission has different types that can be divided as follows, which is shown in **Figure 11** [**38**]:

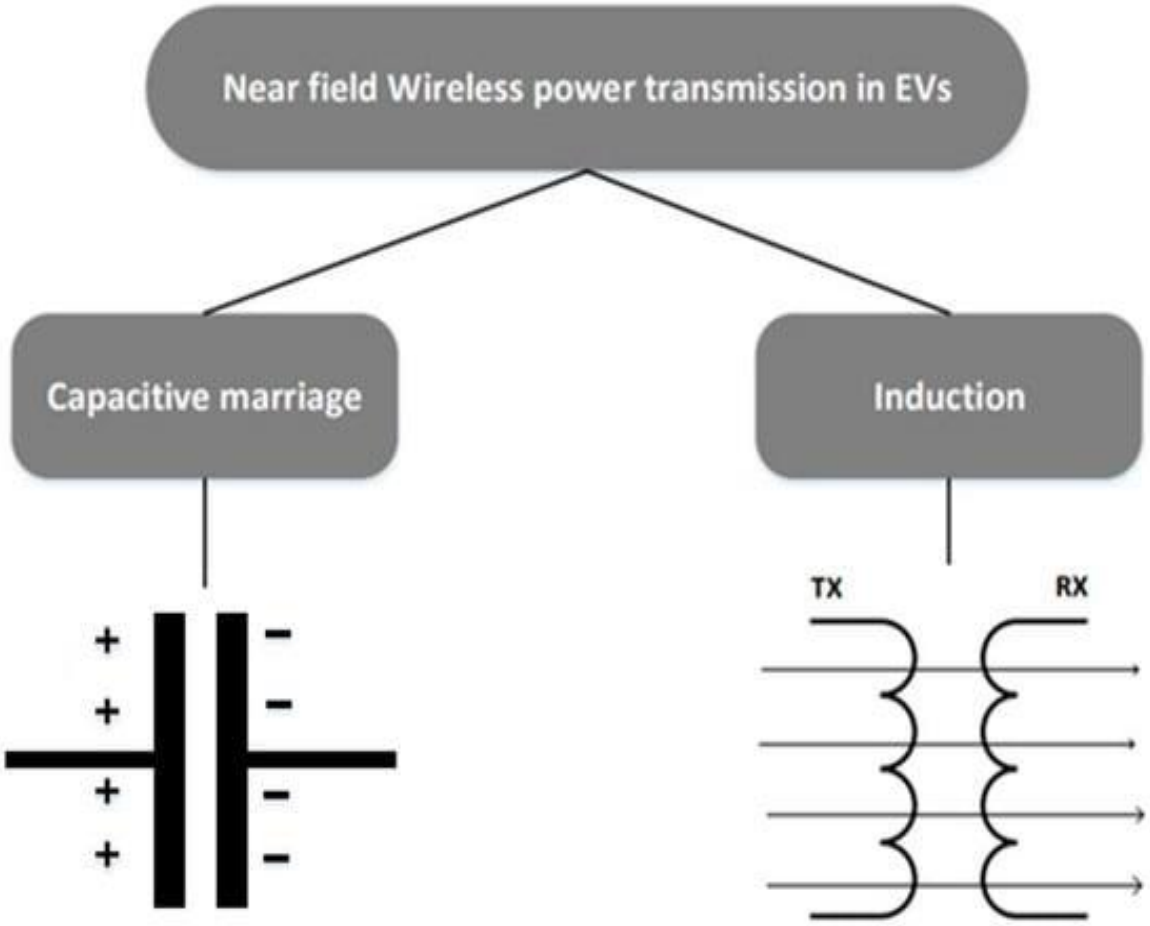


Figure 11. Types of wireless power transmission.

Induction wireless power transmission: Capacitive coupling wireless power transmission.

This study focuses on power transmission at close distances.

Induction wireless power transmission mode: Induction Power Transfers (IPTs) are commonly used to transmit power wirelessly, and they have problems. Problems of this type of induced wireless power transmission can be called eddy current losses. The advantages of this type of transmission include safe power transfer on a rainy day, long life, and high reliability [**39**]. **Figure 12** depicts a schematic of induction WPT.

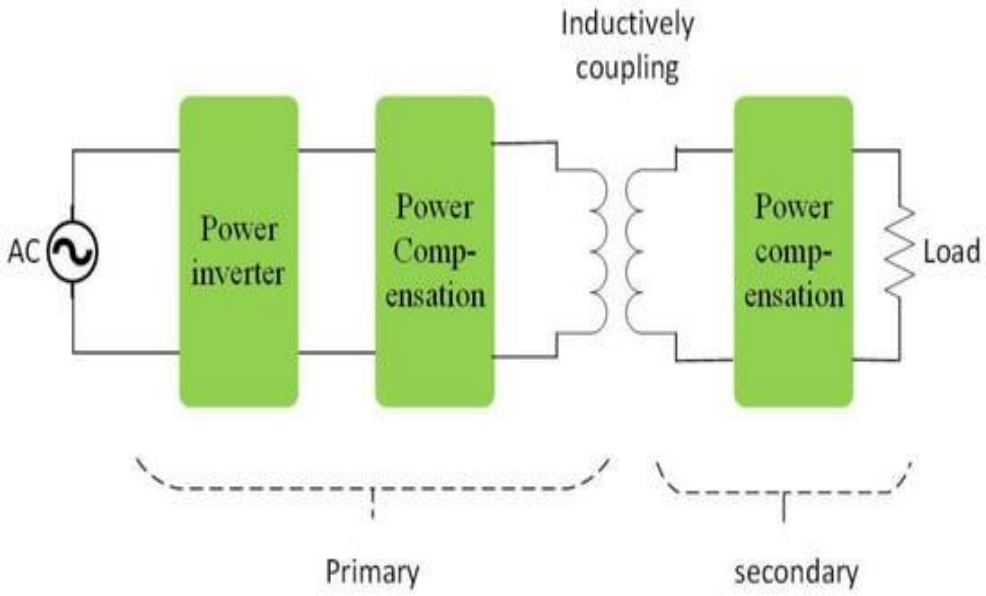


Figure 12. Induction wireless power transmission.

Capacitive coupling wireless power transmission mode: This model's field coupling, also known as capacitive power transfer (CPT), offers some advantages. This method overcomes the restriction that magnetic energy cannot pass through a metal shield or plate and achieves this while also reducing energy losses, keeping magnetic field interference at a reasonable level, and avoiding field interference. It makes the system operate in a saturated state, a strong magnetic field, and also when there is an electric field present [**39**]. However, this mode of power transmission can be very dangerous for humans, due to the sudden discharge of high voltage of this type of power transmission. We see an example of this in **Figure 13**.

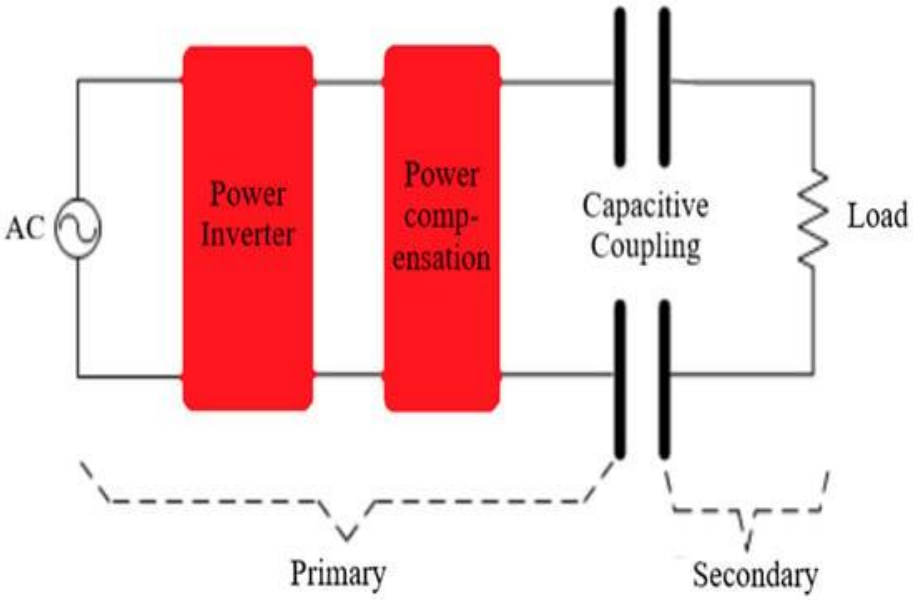


Figure 13. Capacitive wireless power transmission.

Additionally, for the long-distance power transmission mode, we will only discuss the microwave mode, which is more useful in the field of telecommunications. This type of power transmission is performed using high-power antennas, which can be seen in **Figure 14**.

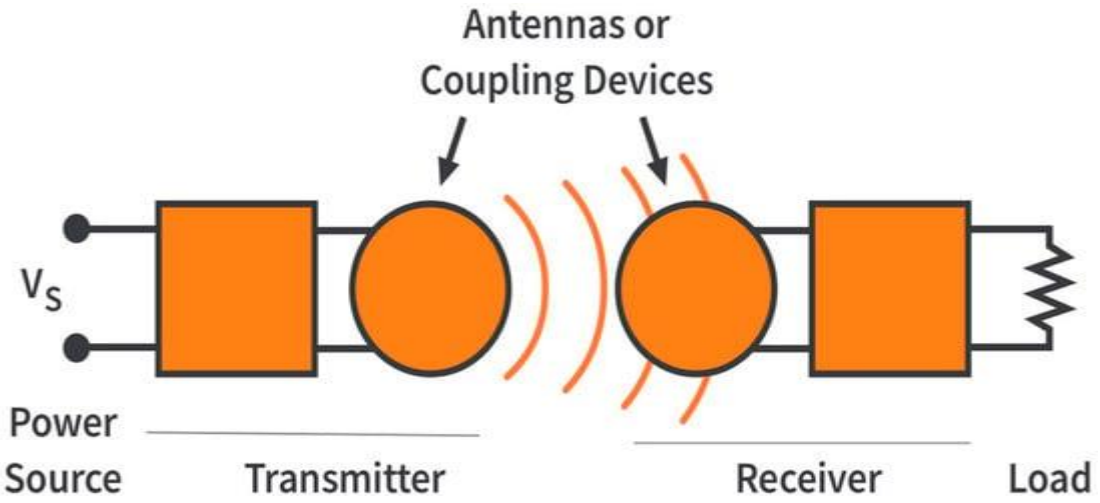


Figure 14. Microwave power transmission.

2.4.1. Important Factors in Wireless Power Transmission: The resonators used should be as light as possible and have low sensitivity to displacement. In addition, these resonators should be able to operate at an average air distance of about (10–20 cm). One of the suitable methods for increasing efficiency is the coupling coefficient and the quality coefficient, which is possible with the proper design of the complex structure of the resonator (wires). To achieve high efficiency, the coupling coefficient k and the quality coefficient Q must be large. In general, the coupling coefficient increases as the air gap increases. If the increase in efficiency is achieved by increasing the power, it cannot be a good method. In the resonance induction method, the magnetic coupling coefficient between the coils, due to the relatively large air gap, compared to the non-resonance induction method, is generally about 0.1 to 0.5, which is about 0.95 for the non-resonance induction method, which has a similar function to transformers. Increasing the quality coefficient increases the efficiency and the smaller the coupling coefficient, the higher the quality coefficient will affect increasing the efficiency [**40**]. The coupling coefficient (*k*) can be obtained from the following equation, which is usually between 0.1 and 0.5:

$K=ML1L2----\surd$ $0.1 < K < 0.5$ $0.1 < \square < 0.5$ (5)

K:$\square$: coupling coefficient;

M: mutual inductance;

$L1$: primary coil inductance$\square$1: primary coil inductance;

$L2$: secondary coil inductance$\square$2: secondary coil inductance.

Additionally, the quality factor Q is usually between 10 and 1000, and numbers below 10 are not acceptable, which is obtained from the following equation:

$Q=\omega LR$ $10 < Q < 1000$ $10 < \square < 1000$ (6)

Q: quality factor$\square$: quality factor;

$\omega=2\pi f$ $\square=2\square\square$;

L: inductance of the coil;

R: resistor of coil.

Additionally, other issues, such as magnetic field interference and safety [**41**], are addressed by measures in the structure of coils.

2.4.2. Compensator: In a wireless power transmission system with resonant coupling, it is essential for employing a compensation network to lower the VA rate of the coil and power supply due to the weak coupling and substantial leakage inductance of the coils [**42**]. The use of capacitors on both the transmitter and receiver sides is the simplest way of addressing inductance leakage. Depending on how the capacitor is placed in the circuit, four types of compensation are possible. For this purpose, they were introduced as series–series (SS), series–parallel (SP), parallel–series (PS), and parallel–parallel (PP), based on configuration [**43**]. These structures are used to compensate for leaks from the induction coil, which is called a compensator [**14**]. The basic topologies are shown in **Figure 15**.

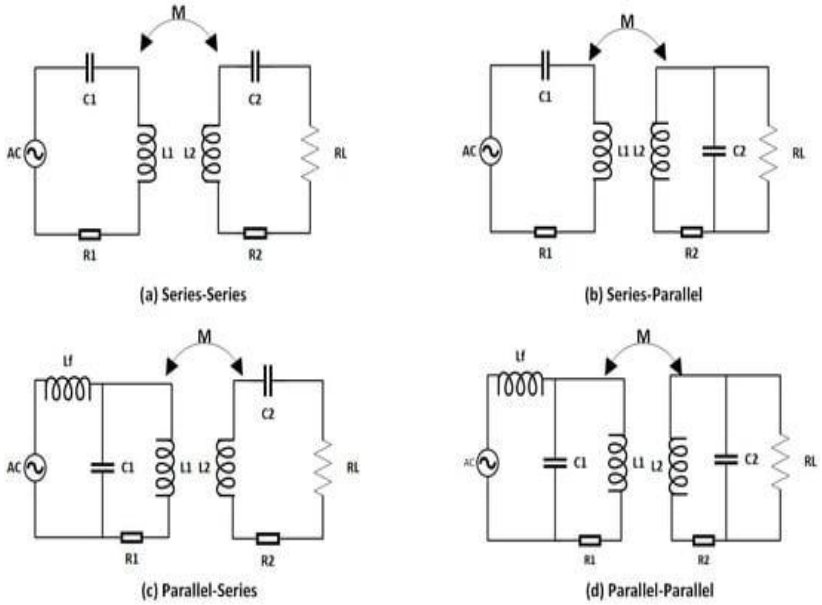


Figure 15. Different types of IPT compensators that: (**a**) (SS), (**b**) (SP), (**c**) (PS), and (**d**) (PP) reference.

The correlations in **Table 3** can be used to compute the values of capacitors based on the layouts of the aforementioned topologies, as shown below [**44**]:

Table 3. Relationships governing the above circuit [**44**].

Now, according to the above explanations and the introduction of compensators, a general comparison of compensators in wireless power transmission is given according to the criteria

of coupling coefficient values and winding weight, misalignment, and voltage value, etc., as shown in **Figure 16** [**45**].

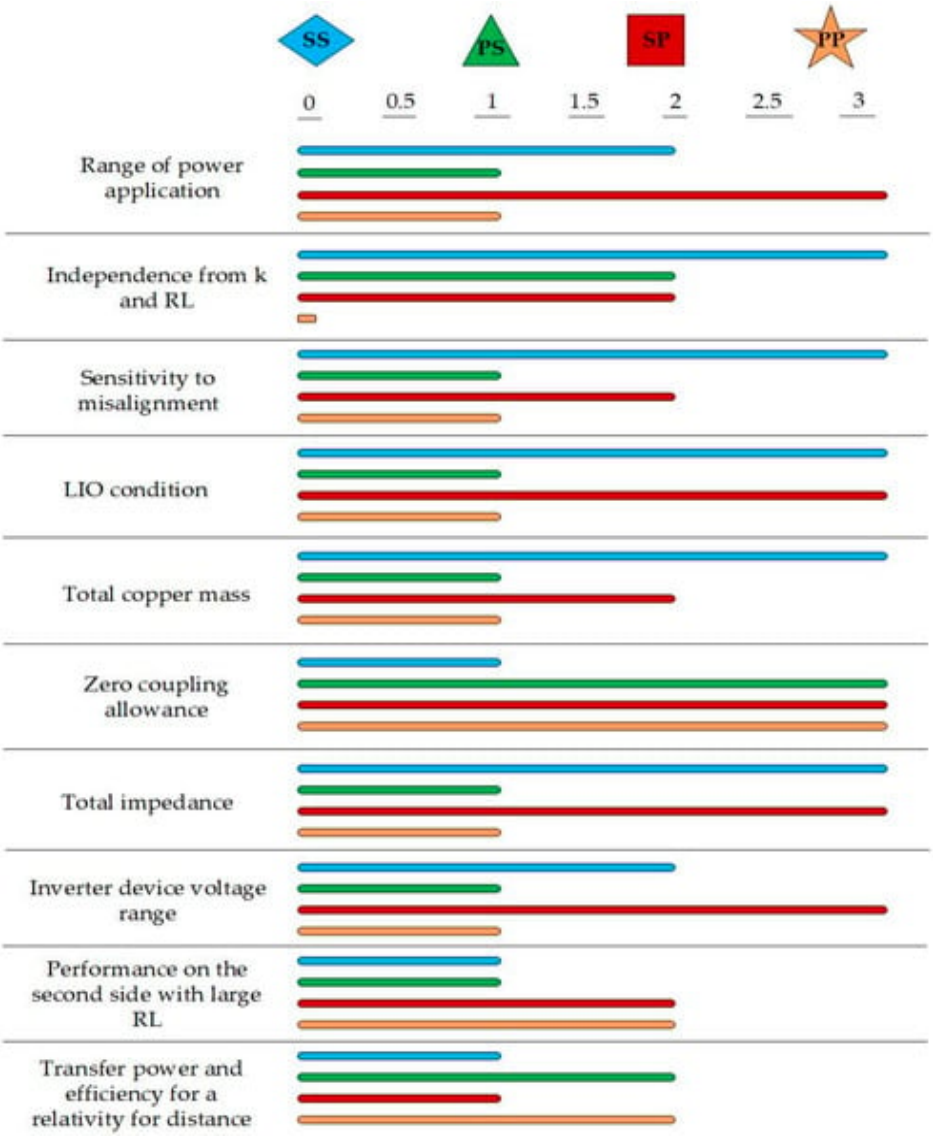


Figure 16. Comparison diagram of the initial topology of compensators.

In light of the comparison in the above figure, the SS structure, which was the simplest and very well topology at the time it was developed and is still in use, is our next choice. As can be observed, this structure has a strong coupling coefficient, but a lot of copper was used in its construction, and it also has a high impedance and poor efficiency with distance.

2.4.3. Coil Structure

As we saw in the previous section, efficiency and safety are important factors in the transfer of wireless power. Among the many ways to improve the two factors we discussed is to change the coil's structure. The information below belongs to the primary coil's construction (**Figure 17**):

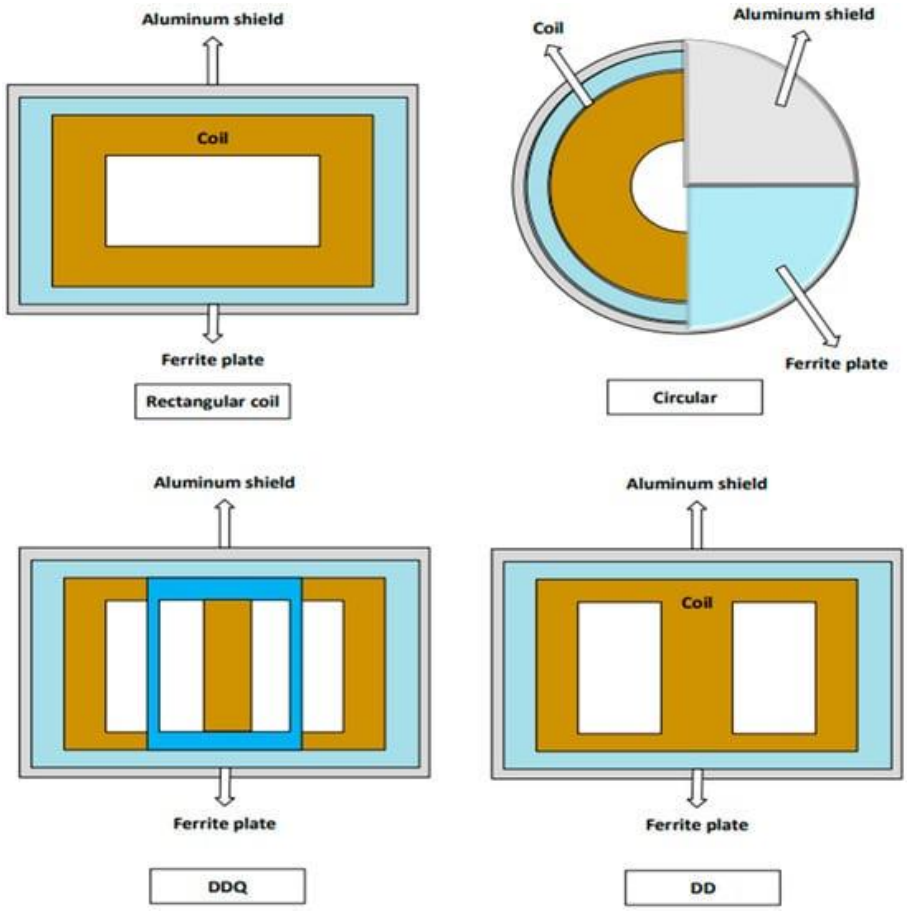


Figure 17. Coil structures. Circular structure; – Rectangular structure; – DD structure; – DDQ structure.

Other structures are also seen in [**46**]. The DDQ structure is the most effective coil structure, as determined by prior research and outcomes. In the next section, we discuss coil structure. The coil construction in Kim's research project [**47**], which depicted a simple circular shape and employed three ferrites' cores in parallel and an aluminum shield to lessen radiation and promote safety. According to Ongayo and Hanif's [**48**] research, the new improved circular structure was suggested, while taking into account the electromagnetic interference (EMI) and electromagnetic field (EMF) effect. As a result, the ferrite core was used to improve the flux path and reduce losses and leakage. However, these plates are typically expensive and delicate, in comparison to their structures. Aluminum shielding is used to reduce magnetic radiation that is harmful to the human body and reduce leakage current. It causes and transmits little power and has a short air distance. The coupling coefficient and efficiency have grown, but on the other hand, the price and weight have gone up. It also transfers a little amount of power in a small air gap.

Table 4 illustrates the results of the simulation, where D is the distance between the transmitting and receiving coils, L1 and L2 are the primary and secondary coil self-inductances, respectively, M is the mutual inductance, and k is the coefficient of coupling. The results make it clear that the L1 and L2 variations, when d changes, are much smaller than the M variance. In each of the three possibilities, M and k increase as the separation

between the two coils decreases. More power is delivered to the output when M and k are bigger. In comparison to the coreless transfer, the values of M and k will rise if a ferrite core is used. A coreless transformer will be light and inexpensive, but it cannot be used for high and efficient power transfer, due to its low coupling factor and mutual inductance. A comparison of shielded and unshielded transformers reveals that the parameters, particularly M and k, change little. As a result of shielding, M and k are only slightly reduced.

Table 4. Circular pad simulation outcomes [**48**].

In a research study [**49**], Mohammad and Choi showed that the DD structure was improved over the circle structure, but the alignment sensitivity was increased. Their results showed that the rough core surface has many core losses. The suggested structure with optimal thickness and smooth structure significantly reduces the core loss. In the optimized core, the losses are reduced up to 60%. The maximum permissible core losses for a specific system are determined by considering the coupling factor and the quality factor for uniform thickness and the suggested optimal core. In [**50**], the DDQ structure was proposed by Mirslim and Rasakh, and compared to the DD structure, the sensitivity to alignment decreased. Their research used two structures, the DDQ structure was located on the receiver or secondary side with a square coil, and the receiver side used a LLC compensator that increases the *X*-axis tolerance, which made the system more compact, and also efficiency increased, compared to the DD structure. Other structures, such as the bipolar pad structure used in [**51**], developed by Mirsalim and Rasekh, for the bipolar structure, which was obtained from two D-pads that were overlapping, and in this paper, using a LCC compensator, using LCC increases the efficiency and improves the lateral (horizontal) misalignment and reduces the size of the transmission plate and examines the effect of coils on each other. In [**52**], they chose the tripolar pad (TP) structure from three coils, and in this article, we used an SS compensator structure. At first, the value of the capacitor is determined in such a way that it removes the imaginary parts of the impedance that can be seen in the output. In this method, the inductive load can keep the compensation and the resonant frequency constant by comparing the two scenarios, and the suitable value for the capacitor can keep the nominal voltage constant in the non-alignment position. As it was said, for the back of the pads, a flat aluminum plate is used to protect and bind the radiation of the electromagnetic field, and ferrite magnet is used to improve the magnetic field, which is an expensive metal. This structure is proposed to reduce the cost and improve efficiency. **Table 5** reviews some recent articles on WPT.

Table 5. Summary of literature review on WPT systems.

3. Application of Artificial Intelligence in WPT

There are several studies on the WPT system that focus on the goal of achieving higher distance transmission. The research has mainly focused on impedance adaptation and the design of resonators [**61**,**62**,**63**], transducers, and power electronics and inverters with appropriate control methods [**64**]. According to the needed performance, which varies depending on the application, WPT systems were constructed. They can be used in many different ways; for example, small coils can be useful in biomedical applications, while medium-sized coils are suitable for wireless charging, and larger coils are made for charging electric vehicles. The types and dimensions of the winding affect the power transmission efficiency and lead to other various changes in different parameters, such as mutual inductance, resonance frequency, and so on [**63**]. Trial and error exercises are time-consuming when calculating parameters, and the outcome may not be altered from a theoretical, simulation-based, or computational standpoint.

WPT and ANN approaches are offered as a way to cut down on this enormous amount of time. An illustration of soft computing is artificial neural networks (ANN), which can handle complicated IT equations and numerous parameter calculations. It is used to identify unidentified parameters and computational methods that simulate an accurate answer quickly. For instance, a WPT design with a high transmission efficiency can be adjusted based on the coil design, inverters, and the volt-ampere (VA) ratings of the active and reactive elements. There is an issue which is related to a huge computational load due to the training all of the combinations of parameters and variables. The WPT design and optimization techniques nowadays can result in a speedier convergence. It is possible to generate reliable outcomes using a variety of soft computing techniques (grouped based on fuzzy, evolutionary logic algorithms, and ANNs) [**65**,**66**,**67**]. ANNs are analogous to a sophisticated processor with a shared aim to preserve useful data and make it accessible for additional usage. ANN functions in two stages. The initial stage is to gather information about a network across the teaching and learning process. Second, weights are the terms used to describe how neurons are connected. The output of neurons is determined by how well the consequences perform. A bigger impact on the output is provided by a connection with more weight. When tackling problems with complicated nonlinearities, neural networks are known as generic estimators, and educational algorithms are a crucial component of neural networks. A primary neural network consists of three types of layers, as seen in **Figure 18** [**68**].

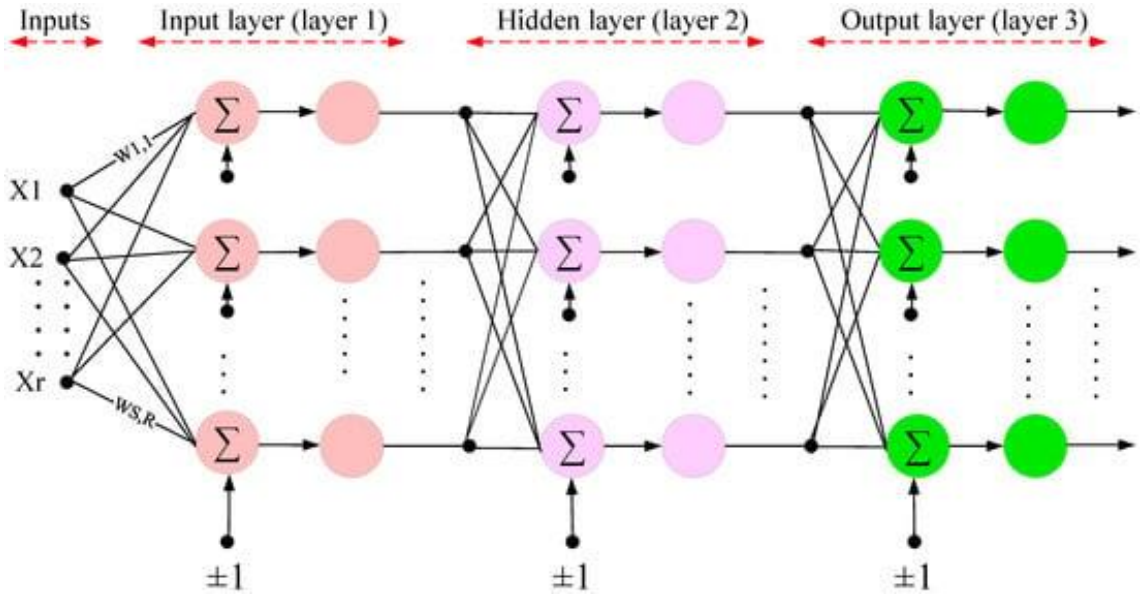


Figure 18. Sample of neural network.

The third layer is the output layer, whereas layers beginning with input layers are connected by certain hidden layers. Different types of neural networks are recognized based on the interactions between layers, and the connection weight minimizes the error between the neural network's acquired and desired outputs. Synaptic connections link the three layers together to train the neural network. As a consequence, an algorithm is appropriate based on the problem for which a resolution is required for the best and most accurate outcome possible. Artificial neural networks are used in numerous applications because of their versatility in a variety of tasks, including adaptive control, system identification, function approximation, and optimization. Researching and finding solutions are other advantages of using ANN techniques. Adopting ANN techniques saves time and money actions, thereby minimizing processing requirements simply by shortening the time spent using the device. Its ability to handle imprecise data and non-linear mapping guarantees its acceptance as part of the simulation. The most popular and fundamental ANN technique is known as regression propagation (BP), also known as error return, and it has been utilized as a method for optimization in many different sectors for a variety of applications. The error correlation learning rule serves as the foundation for BP propagation, which has at least three interconnected layers. The first layer's output serves as the operation's starting point, and from there, the connection procedure is repeated until the final receipt. Particle swarm optimization (PSO) and genetic algorithms (GA) are two more common methods employed because they are simpler than BP. A crowd-based community behavior called ethics serves as the inspiration for the stochastic approach known as PSO. PSO and GA are virtually the same in that they loop through a generation hunting group in search of the best outcome with a random population. However, evolutionary operations, including crossover and mutation, are not incorporated in the PSO algorithm [**69**,**70**]. Instead, particles fly in search of the problem area the optimal result follows the current optimality particles.

In WPT, several BP, GA, and PSO optimization and modification techniques are used. They enhance: (A) The coil design; (B) frequency division and consistency; (C) power transfer efficiency (PTE); (D) energy management; (E) converter (power electronics), and fault analysis. In WPT, optimization using ANN is primarily concentrated on enhancing PTE, and validation of ANN is typically accomplished by contrasting the findings of ANN by employing software for finite element analysis (FEM). MATLAB or ANSYS Maxwell HFSS are used. It is challenging to forecast each value, since there are many variables that affect the process of creating a steady output, including the primary coil, current, and location of the transmitter and receiver coils at the time of the reception unit and route. The output current and parameter changes might be kept constant to account for undetected BP disorders. The PID controller receives the BP train, and MATLAB/Simulink are often used to model the system [**70**]. Some articles on the use of artificial intelligence in WPT have been reviewed in **Table 6**.

Table 6. Literature review on applications of AI for WPT.

4. Recommendations and Future Work

Today, due to the growth of using electric vehicles, the need for charging EV stations has increased, in which one of the sources that can be used in charging stations is a photovoltaic system, and we also discussed that the best method for charging electric vehicles is wireless method, which can be improved by using the following suggestions:

(1) Using wireless charging during vehicle movement, which will reduce the cost of energy storage units.

(2) Improving wireless power transmission by using new coil structures and using new resonances suitable for improving power transmission.

(3) Applying the new MPPT algorithm or combine several algorithms to improve solar panel output energy.

(4) Using new converters or a combination of existing converters that can be used for this type of system.

(5) Creating a wireless charger that can quickly charge a vehicle, compared to the time it takes to do so using a plug-in charger.

(6) More consideration and study must be given to enhancing shielding, in order to promote health and safety.

(7) Implementing reinforcement learning and deep learning algorithms to reduce misalignment errors.

(8) Employing quantum computing methods for better power transmission with more precision and speed.

(9) We need to find innovative methods to reduce the cost of materials (especially for the dynamic charge method).

5. Conclusions

This paper presents and investigates current technologies for wireless charging electric vehicles with solar energy. Due to the fact that WPT technology and solar energy use are reliable, practical, and effective charging techniques, they are currently the subject of intensive research in academia and industry. In this review paper, we explored electric cars and the type of charging modes. According to the discussions, when more electric vehicles are produced, the photovoltaic system may offer a promising energy source to power them.

The method of generating electricity from solar energy and the general classification of photovoltaic systems are divided into two groups, grid-connected and off-grid, and the parts used for this purpose were discussed. Additionally, MPPT approaches were studied, and the P&O method was frequently picked for the MPPT algorithm, due to its straightforward implementation and excellent accuracy. We looked at and evaluated various storage technologies, including lithium-ion batteries, which are frequently used in electric cars due to their compact size, light weight, and high efficiency. EV connection types to the grid and static and dynamic wireless charging techniques were also explored.

This paper also examined the development of wireless power transfer, as well as its various forms and uses. To improve the critical elements in wireless power transmission, we also reviewed the crucial elements in power transmission and looked at various coil and compensator structures, as well as the important factors and shielding effect in WPT. We also review some recent papers on wireless charging EVs in **Table 5**. A cutting-edge analysis was performed on creating artificial intelligence for the WPT system. As a consequence of this research, we were able to identify the most crucial factors for creating an AI model for WPT systems, which we have listed in **Table 6**. Compared to plug-in chargers, the primary objective of WPT charging systems is to be more effective. This article identifies several significant challenges and prospective research projects. By overcoming these challenges, wireless chargers have the potential for commercial use. While deploying dynamic or static wireless chargers in the real world, ecological, financial, and performance, in terms of efficiency, sustainability, and reliability, must be carefully evaluated. Using dynamic wireless chargers as a distribution and communication line needs to be further studied. It is necessary to conduct more research on the utilization and storage of various renewable energy sources.

Future advancements in WPT can be used to automate and commercialize wireless charging systems.

References

[1] Farsaei, A.; Syri, S.; Olkkonen, V.; Khosravi, A. Unintended Consequences of National Climate Policy on International Electricity Markets—Case Finland's Ban on Coal-Fired Generation. Energies 2020, 13, 1930.

[2] Arif, Z.; Ravikiran, V.; Kumar Keshri, R. Design of PV Fed Wireless Charger For Electric Vehicle. In Proceedings of the 2020 International Conference on Power Electronics & IoT Applications in Renewable Energy and Its Control (PARC), Mathura, India, 28–29 February 2020.

[3] Mahesh, A.; Chokkalingam, B.; Mihet-Popa, L. Inductive Wireless Power Transfer Charging for Electric Vehicles–A Review. IEEE Access 2021, 9, 137667–137713.

[4] Mi, C.C.; Buja, G.; Choi, S.Y.; Rim, C.T. Modern Advances in Wireless Power Transfer Systems for Roadway Powered Electric Vehicles. IEEE Trans. Ind. Electron. 2016, 63, 6533–6545.

[5] Campbell, C.J.; Duncan, R.C. The Coming Oil Crisis; Multi-Science Publishing: Brentwood, UK, 1997.

[6] Falvo, M.C.; Sbordone, D.; Bayram, I.S.; Devetsikiotis, M. EV charging stations and modes: International standards. In Proceedings of the 2014 International Symposium on Power Electronics, Electrical Drives, Automation and Motion, Ischia, Italy, 18–20 June 2014; IEEE: Piscataway, NJ, USA, 2014; pp. 1134–1139.

[7] Singh, A.; Shaha, S.S.; Nikhil, P.G.; Sekhar, Y.R.; Saboor, S.; Ghosh, A. Design and Analysis of a Solar-Powered Electric Vehicle Charging Station for Indian Cities. World Electr. Veh. J. 2021, 12, 132.

[8] Teng, J.-H.; Huang, W.-H.; Hsu, T.-A.; Wang, C.-Y. Novel and Fast Maximum Power Point Tracking for Photovoltaic Generation. IEEE Trans. Ind. Electron. 2016, 63, 2551678.

[9] Chomać-Pierzecka, E.; Kokiel, A.; Rogozińska-Mitrut, J.; Sobczak, A.; Soboń, D.; Stasiak, J. Analysis and Evaluation of the Photovoltaic Market in Poland and the Baltic States. Energies 2022, 15, 669.

[10] Rasel, S.I.; Ali, R.N.; Chowdhury, M.S.U.; Hasan, M.M. Design & Simulation of Grid Connected Photovoltaic System Using Simulink. In Proceedings of the International Conference on Advances in Electrical Engineering (ICAEE), Dhaka, Bangladesh, 17–19 December 2015.

[11] Al-Amoudi, A.; Zhang, L. Optimal Control of a Grid-Connected Pv System for Maximum Power Point Tracking and Unity Power Factor. In Proceedings of the Seventh International Conference on Power Electronics and Variable Speed Drives, London, UK, 21–23 September 1998.

[12] Sampaio, P.G.V.; González, M.O.A. Photovoltaic solar energy: Conceptual framework. Renew. Sustain. Energy Rev. 2017, 74, 590–601.

[13] Peng, J.; Lu, L.; Yang, H. Review on life cycle assessment of energy payback and greenhouse gas emission of solar photovoltaic systems. Renew. Sustain. Energy Rev. 2013, 19, 255–274.

[14] Joseph, P.K.; Elangovan, D.; Sanjeevikumar, P. System Architecture, Design, and Optimization of a Flexible Wireless Charger for Renewable Energy-Powered Electric Bicycles. IEEE Syst. J. 2020, 15, 2696–2707.

[15] Kabayashi, K.; Takano, I.; Sawada, Y. A Study on a Two-Stage Maximum Power Point Tracking Control of a Photovoltaic System under Partially Shaded Insolation Condition. In Proceedings of the 2003 IEEE Power Engineering Society General Meeting, Toronto, ON, Canada, 13–17 July 2003.

[16] Mosammam, B.M.; Mirsalim, M.; Khorsandi, A. Modeling, Analysis, and SS Compensation of the Tripolar Structure of Wireless Power Transfer (WPT) System for EV Applications. In Proceedings of the 2020 11th Power Electronics, Drive Systems, and Technologies Conference, Tehran, Iran, 4–6 February 2020.

[17] Piegari, L.; Rizzo, R. Adaptive Perturb and Observe Algorithm for Photovoltaic Maximum Power Point Tracking. IET Renew. Power Generator. 2010, 4, 317–328.

[18] Caval-Canti, M.C.; Oliveira, K.C.; Azevedo, G.M.; Moreira, D.; Neves, F.A. Maximum Power Point Tracking Techniques for Photovoltaic System. In Proceedings of the PELINCEC 2005 Conference, Warsaw, Poland, 15–20 October 2005.

[19] Liu, X.; Lopes, L.A.C. An Improved Perturbation and Observation Maximum Power Point Tracking Algorithm for PV Array. In Proceedings of the 35th Annual IEEE Power Electronics Specialists Conference, Aachen, Germany, 20–25 June 2004.

[20] Sujatha, B.G.; Aruna, Y.V. Wireless charging of elecrtic vehicles using solar energy. Gradiva Rev. J. 2022, 8, 167.

[21] Al Nabulsi, A.; Dhaouadi, R. Efficiency Optimization of a Dsp-Based Standalone PV System Using Fuzzy Logic and Dual-MPPT Control. IEEE Trans. Ind. Inform. 2012, 8, 573–584.

[22] Algazar, M.M.; Al-Monier, H.; El-Halim, H.A.; Salem, M.E.E.K. Maximum power point tracking using fuzzy logic control. Int. J. Electr. Power Energy Syst. 2012, 39, 21–28.

[23] Mohamed, M.A.; Mohamed, F.A. Design and Simulate an Off-Grid PV System with a Battery Bank for EV Charging. Univers. J. Electr. Electron. Eng. 2020, 7, 273–288.

[24] Algarín, C.R.; Giraldo, J.T.; Álvarez, O.R. Fuzzy Logic Based MPPT Controller for a PV System. Energies 2017, 10, 2036.

[25] Rufer, A. On the efficiency of energy storage systems-the influence of the exchanged power and the penalty of the auxiliaries. Facta Univ.-Ser. Electron. Energ. 2021, 34, 173–185.
[26] Kakimoto, N.; Fujii, Y. Inherent Equalization of Lithium-Ion Batteries Based on Leakage Current. IEEE Trans. Sustain. Energy 2018, 10, 170–180.
[27] Li, Z.; Song, K.; Jiang, J.; Zhu, C. Constant Current Charging and Maximum Efficiency Tracking Control Scheme for Supercapacitor Wireless Charging. IEEE Trans. Power Electron. 2018, 33, 9088–9100.
[28] Panchal, C.; Stegen, S.; Lu, J. Review of static and dynamic wireless electric vehicle charging system. Eng. Sci. Technol. Int. J. 2018, 21, 922–937.
[29] Vilathgamuwa, D.M.; Sampath, J.P.K. Wireless Power Transfer (WPT) for Electric Vehicles (EVs)—Present and Future Trends. Power Syst. 2015, 91, 33–60.
[30] Lu, F.; Zhang, H.; Hofmann, H.; Mi, C. A Double-Sided LCLC-Compensated Capacitive Power Transfer System for Electric Vehicle Charging. IEEE Trans. Power Electron. 2015, 30, 6011–6014.
[31] Kalwar, K.A.; Aamir, M.; Mekhilef, S. Inductively coupled power transfer (ICPT) for electric vehicle charging—A review. Renew. Sustain. Energy Rev. 2015, 47, 462–475.
[32] Musavi, F.; Edington, M.; Eberle, W. Wireless Power Transfer: A Survey of EV Battery Charging Technologies. In Proceedings of the Energy Conversion Congress and Exposition(ECCE) IEEE, Raleigh, NC, USA, 15–20 September 2012; pp. 1804–1810.
[33] Leskarac, D.; Panchal, C.; Stegen, S.; Lu, J. PEV Charging Technologies and V2G on Distributed Systems and Utility Interfaces. In Vehicle-to-Grid: Linking Electric Vehicles to the Smart Grid; Lu, J., Hossain, J., Eds.; Institution of Engineering and Technology: London, UK, 2015; pp. 157–222.
[34] Singh, M.; Kumar, P.; Kar, I. A Multi Charging Station for Electric Vehicles and Its Utilization for Load Management and the Grid Support. IEEE Trans. Smart Grid 2013, 4, 1026–1037.
[35] Are We Ready For Vehicle-To-Grid (V2G) Technology? Electrical Engineering News and Products. Available online: https://www.eeworldonline.com/are-we-ready-for-vehicle-to-grid-V2g-technology/ (accessed on 17 November 2022).
[36] Kurs, A.; Karalis, A.; Moffatt, R.; Joannopoulos, J.D.; Fisher, P.; Soljačić, M. Wireless Power Transfer via Strongly Coupled Magnetic Resonances. Science 2007, 317, 83–86.
[37] Faraday's Law. Available online: http://hyperphysics.phyastr.gsu.edu/hbase/electric/farlaw.html (accessed on 17 November 2022).
[38] Popovic, Z. Near- and Far-Field Wireless Power Transfer. In Proceedings of the 2017 13th International Conference on Advanced Technologies, Systems and Services in Telecommunications (TELSIKS), Nis, Serbia, 18–20 October 2017.
[39] Chen-Yang, X.; Chao-Wei, L.; Juan, Z. Analysis of power transfer characteristic of capacitive power transfer system and inductively coupled power transfer system. In Proceedings of the 2011 International Conference on Mechatronic Science, Electric Engineering and Computer (MEC), Jilin, China, 19–22 August 2011.
[40] Li, S.; Mi, C.C. Wireless Power Transfer for Electric Vehicle Applications. IEEE J. Emerg. Sel. Top. Power Electron. 2015, 3, 4–17.
[41] What Are Electromagnetic Fields? World Health Organization, 04-Aug-2016. Available online: https://www.who.int/peh-emf/about/whatisemf/en/index1.html (accessed on 17 November 2022).
[42] Wu, H.H.; Gilchrist, A.; Sealy, K.D.; Bronson, D. A High Efficiency 5 kW Inductive Charger for EVs Using Dual Side Control. IEEE Trans. Ind. Informatics 2012, 8, 585–595.
[43] Stielau, O.H.; Covic, G.A. Design of Loosely Coupled Inductive Power Transfer Systems. In Proceedings of the 2000 International Conference on Power System Technology, Beijing, China, 16–19 August 2009.
[44] Okasili, I.; Elkhateb, A.; Littler, T. A Review of Wireless Power Transfer Systems for Electric Vehicle Battery Charging with a Focus on Inductive Coupling. Electronics 2022, 11, 1355.
[45] Zhang, Z.; Pang, H.; Georgiadis, A.; Cecati, C. Wireless Power Transfer—An Overview. IEEE Trans. Ind. Electron. 2019, 66, 1044–1058.
[46] Ahmad, A.; Alam, M.S.; Mohamed, A.A.S. Design and Interoperability Analysis of Quadruple Pad Structure for Electric Vehicle Wireless Charging Application. IEEE Trans. Transp. Electrif. 2019, 5, 934–945.
[47] Kim, J.; Kim, J.; Kong, S.; Kim, H.; Suh, I.-S.; Suh, N.P.; Cho, D.-H.; Kim, J.; Ahn, S. Coil Design and Shielding Methods for a Magnetic Resonant Wireless Power Transfer System. Proc. IEEE 2013, 101, 1332–1342.
[48] Ongayo, D.; Hanif, M. Comparison of circular and rectangular coil transformer parameters for wireless Power Transfer based on Finite Element Analysis. In Proceedings of the 2015 IEEE 13th Brazilian Power Electronics Conference and 1st Southern Power Electronics Conference (COBEP/SPEC), Fortaleza, Brazil, 29 November–2 December 2015; pp. 1–6.
[49] Mohammad, M.; Choi, S. Optimization of ferrite core to reduce the core loss in double-D pad of wireless charging system for electric vehicles. In Proceedings of the 2018 IEEE Applied Power Electronics Conference and Exposition, San Antonio, TX, USA, 4–8 March 2018.
[50] Rasekh, N.; Mirsalim, M. Design of a compact and efficient Bipolar pad with a new integration of LCC

compensation method for WPT. In Proceedings of the 2018 9th Annual Power Electronics, Drives Systems and Technologies Conference (PEDSTC), Tehran, Iran, 13–15 February 2018.
[51] Rasekh, N.; Kavianpour, J.; Mirsalim, M. A Novel Integration Method for a Bipolar Receiver Pad Using LCC Compensation Topology for Wireless Power Transfer. IEEE Trans. Veh. Technol. 2018, 67, 7419–7428.
[52] Tozlu, .F.; Çalık, H. A Review and Classification of Most Used MPPT Algorithms for Photovoltaic Systems. Hittite J. Sci. Eng. 2021, 8, 207–220.
[53] Siroos, A.; Sedighizadeh, M.; Afjei, E.; Sheikhi Fini, A.; Yarkarami, S. System Identification and Control Design of a Wireless Charging Transfer System with Double-Sided LCC Converter. Arab. J. Sci. Eng. 2021, 46, 9735–9739.
[54] Al-Saadi, M.; Ibrahim, A.; Al-Omari, A.; Al-Gizi, A.; Craciunescu, A. Analysis and Comparison of Resonance Topologies in 6.6 kW Inductive Wireless Charging for Electric Vehicles Batteries. Procedia Manuf. 2019, 32, 426–433.
[55] Zhao, H.; Liu, K.; Li, S.; Yang, F.; Cheng, S.; Eldeeb, H.H.; Kang, J.; Xu, G. Shielding Optimization of IPT System Based on Genetic Algorithm for Efficiency Promotion in EV Wireless Charging Applications. IEEE Trans. Ind. Appl. 2021, 58, 1190–1200.
[56] Gonzalez-Gonzalez, J.M.; Trivino-Cabrera, A.; Aguado, J.A. Model Predictive Control to Maximize the Efficiency in EV Wireless Chargers. IEEE Trans. Ind. Electron. 2021, 69, 1244–1253.
[57] Lee, J.-Y.; Han, B.-M. A Bidirectional Wireless Power Transfer EV Charger Using Self-Resonant PWM. IEEE Trans. Power Electron. 2014, 30, 1784–1787.
[58] CCai, C.; Wang, J.; Fang, Z.; Zhang, P.; Hu, M.; Zhang, J.; Li, L.; Lin, Z. Design and Optimization of Load-Independent Magnetic Resonant Wireless Charging System for Electric Vehicles. IEEE Access 2018, 6, 17264–17274.
[59] Cui, S.; Wang, Z.; Han, S.; Zhu, C.; Chan, C.C. Analysis and Design of Multiphase Receiver With Reduction of Output Fluctuation for EV Dynamic Wireless Charging System. IEEE Trans. Power Electron. 2018, 34, 4112–4124.
[60] Patil, D.; Miller, J.M.; Fahimi, B.; Balsara, P.T.; Galigerkere, V. A Coil Detection System for Dynamic Wireless Charging of Electric Vehicle. IEEE Trans. Transp. Electrif. 2019, 5, 988–1003.
[61] Das Barman, S.; Reza, A.W.; Kumar, N.; Karim, M.E.; Munir, A.B. Wireless powering by magnetic resonant coupling: Recent trends in wireless power transfer system and its applications. Renew. Sustain. Energy Rev. 2015, 51, 1525–1552.
[62] Kim, Y.-H.; Kang, S.-Y.; Cheon, S.; Lee, M.-L.; Lee, J.-M.; Zyung, T. Optimization of wireless power transmission through resonant coupling. In Proceedings of the SPEEDAM 2010, Pisa, Italy, 14–16 June 2010.
[63] Jawad, A.M.; Nordin, R.; Gharghan, S.K.; Jawad, H.M.; Ismail, M. Opportunities and Challenges for Near-Field Wireless Power Transfer: A Review. Energies 2017, 10, 1022.
[64] Imura, T.; Hori, Y. Maximising Air Gap and Efficiency of Magnetic Resonant Coupling for Wireless Power Transfer Using Equivalent Circuit. IEEE Trans. Ind. Electron. 2011, 58, 4746–4752.
[65] Chen, W.; Chinga, R.A.; Yoshida, S.; Lin, J.; Chen, C.; Lo, W. A 25.6 W 13.56 MHz wireless power transfer system with a 94% efficiency GaN Class-E power amplifier. In Proceedings of the 2012 IEEE/MTT-S International Microwave Symposium Digest, Montreal, QC, Canada, 17–22 June 2012.
[66] Laskovski, A.N.; Yuce, M.R. Class-E oscillators as wireless power transmitters for biomedical implants. In Proceedings of the 2010 3rd International Symposium on Applied Sciences in Biomedical and Communication Technologies (ISABEL 2010), Rome, Italy, 7–10 November 2010.
[67] Nataraj, C.; Khan, S.; Habaebi, M.H.; Muthalif, A.G.; Arshad, A. Resonant coils analysis for inductively coupled wireless power transfer applications. In Proceedings of the 2016 IEEE International Instrumentation and Measurement Technology Conference Proceedings, Taipei, Taiwan, 23–26 May 2016.
[68] Khosravi, A.; Machado, L.; Nunes, R. Time-series prediction of wind speed using machine learning algorithms: A case study Osorio wind farm, Brazil. Appl. Energy 2018, 224, 550–566.
[69] Suresh, A.; Harish, K.V.; Radhika, N. Particle Swarm Optimisation over Back Propagation Neural Network for Length of Stay Prediction. Procedia Comput. Sci. 2015, 46, 268–275.
[70] Ali, A.; Yasin, M.N.M.; Jusoh, M.; Hambali, N.A.M.A.; Rahim, S.R.A. Optimization of wireless power transfer using artificial neural network: A review. Microw. Opt. Technol. Lett. 2019, 62, 651–659.
[71] Wang, M.; Feng, J.; Shi, Y.; Shen, M.; Jing, J. A novel pso-based transfer efficiency optimization algorithm for wireless power transfer. Prog. Electromagn. Res. C 2018, 85, 63–75.
[72] Wen, F.; Jing, F.; Zhao, W.; Han, C.; Chu, Z.; Li, Q.; Chu, X.; Zhu, X. Research on optimal receiver radius of wireless power transfer system based on BP neural network. Energy Rep. 2020, 6, 1450–1455.
[73] Li, Y.; Dong, W.; Yang, Q.; Zhao, J.; Liu, L.; Feng, S. An Automatic Impedance Matching Method Based on the Feedforward-Backpropagation Neural Network for a WPT System. IEEE Trans. Ind. Electron. 2018, 66, 3963–3972.
[74] He, L.; Zhao, S.; Wang, X.; Lee, C.-K. Artificial Neural Network-Based Parameter Identification Method for Wireless Power Transfer Systems. Electronics 2022, 11, 1415.

[75] Tavakoli, R.; Pantic, Z. ANN-based algorithm for estimation and compensation of lateral misalignment in dynamic wireless power transfer systems for EV charging. In Proceedings of the 2017 IEEE Energy Conversion Congress and Exposition (ECCE), Cincinnati, OH, USA, 1–5 October 2017

[76] El-Sharkh, M.Y.; Touma, D.W.F.; Dawoud, Y. Artificial Neural Network Based Wireless Power Transfer Behavior Estimation. In Proceedings of the 2019 SoutheastCon, Huntsville, AL, USA, 1–14 April 2019

CHAPTER-3.4

Review of Artificial Intelligence's Role in the Internet of Things

Priyanka Chauhan
Assistant professor, Electrical Engineering Department, JBIT Dehradun
Priyanka.chauhan529@gmail.com

ABSTRACT: *The Internet of Things (IoT) offers the opportunity to collect continuous data about a company's physical activities. Computerized reasoning (AI) is assuming a developing role in IoT applications and organisations, signalling a clear shift in the operations of organisations working in this field. Organizations all over the world are rapidly utilising IoT to create new systems of products and administration, which are opening up new business opportunities and making new plans of action. The subsequent change is ushering in a new era of how businesses conduct their operations and interact with customers. For businesses that can transform raw IoT data into useful business intelligence, there is a large open door. Powerful information diagnostics provide the means to do this. Associations are currently under pressure to dig deeper into their data to find fresh, creative ways to increase their effectiveness and seriousness. Associations are acquiring more expansive, increasingly complete investigation approaches as a result of continuous advancements in science and innovation, particularly in AI. Organizations must combine IoT with rapidly advancing AI advancements in order to fully comprehend the potential of IoT enablement. These innovations allow "bright robots" to mimic human intelligence and make highly informed decisions with essentially no human intervention. Today's IoT-based computerised biological systems are becoming increasingly dependent on the coordination of AI. Hence, businesses need to decide soon how they'll benefit from combining IoT with AI, or they risk having to play catch-up in the years to come. In this essay, we'll look at the growth of the Internet of Things and discuss how best to use it to advance companies in the future when combined with AI. There is a solid conviction that approved examination plans together with computerised reasoning will be of notable preferable position in aiding people in fighting this infection because ongoing development in cutting-edge technology has paid off in improving people's survivals. IoT helps a COVID-19-infected patient identify symptoms and receive better care more rapidly. It is beneficial for the board structure of the emergency clinic, doctor, and specialist.*

INTRODUCTION

Dynamic company ventures are mobilizing in a new era where they are demonstrating their exchange activities by utilizing IoT and subsequently creating as excellent as ever business opportunities. IoT is now being integrated with the developing Artificial Intelligence innovations, enabling the undertaking to arrive at familiar decisions without human mediation, to address the full capacity of the appropriation. IoT is currently the leading advancement, as has been noted previously. In any event, the generous impact that artificial intelligence will have on the different aspects of our personal and professional life is less generally enlightening than the effect that would result from combining it with the unthinkable notion of IoT [1][2].

ARTIFICIAL INTELLIGENCE: A LOOK AT ITS SIGNIFICANCE

Artificial intelligence (AI) is the capacity of a serious Computer or PC meticulous robot to carry out duties often associated with attentive beings. Artificial intelligence (AI) hints at

technological devices that can replace human knowledge in the presentation of explicit endeavours. It is possible for robots to pick up information practically, adapt to new sources of knowledge, and complete tasks that resemble those performed by a person. Mimicked knowledge has been adopted into people's vocations as of right now and will continue to do so, for instance, as it becomes ever more thoroughly understood and compelling. The uses of artificial intelligence are shown in Figure 1.

Figure 1. Uses of artificial intelligence

The potential of AI is appealing to every sector.

• To provide personalised medicine and X-ray readings, as well as personal medical care partners in the medical area.

• To provide online buying capabilities that let customers and providers discuss purchasing choices.

• To analyse creation line data as it comes in from associated rigs to evaluate predicted weight and solicitation employing ad hoc frameworks.

• The board tries to understand which deals are likely to be fake, master quick and accurate credit rating, and motorize really unusual data. [3]

Artificial intelligence is capable of rational thought free from emotion, making decisions with little or no error. As AI doesn't become weary or exhausted, it doesn't need to take pauses, relax, or get involved.

THE INTERNET OF THINGS AND ITS RELEVANCE

The Internet of Things (IoT) describes the arrangement of physical objects, or "things," that are implanted with sensors, programming, and numerous headways to interface and replace information with various devices and structures through the web. These tactics cover everything from basic nuclear family utensils to sophisticated modern gadgets.

IoT gives devices/items the ability to observe, identify, and interpret a situation or environmental conditions without the need for human intervention. From common items like kitchen appliances, cars, interior regulators, and kid displays — to the web utilising connected implanted devices. IoT is heavily employed in many official disasters, much like AI expertise. Applications of IoT are shown in Figure 2.

Figure 2. IoT Applications

• Manufacturing — By applying creation line checks to enable proactive assistance on hardware when sensors detect an impending setback.

• Automotive – Sensors can identify equipment that is beginning to cause discontent in moving cars starting from the moment they are on the road, and they can provide the driver with specifics and advice.

• Retail — To manage inventory, improve customer awareness, improve the flexibility of the supply chain, and cut operating costs.

• Healthcare — To test IoT asset monitoring programmes.

Based on	**Internet of Things**	**Artificial Intelligence**
Connection type	A group of devices connected through a network	As the machine is autonomous, connecting to it is not necessary.
Capabilities	Device specifications have been previously known	Machine capabilities can never be predicted
Interaction	The urge for human interaction	Human contact is not necessary.
Future scope	Human direction is required.	Human direction is not required
Need for Instructions	Devices needed to be instructed	Machine learning is based on experiences.
Dependency	Without AI, IoT won't function.	IoT is not necessary for AI.
Applications	Applications include water monitoring, smart wearables, smart cities, and smart homes.	Chatbots, job advertisements, natural language processing, speech recognition, machine vision, and other applications are some examples.

Table 1: compares IoT and AI technologies.

UNDERSTANDING ARTIFICIAL INTELLIGENCE'S ROLE ON THE INTERNET OF THINGS REVOLUTION

Simulated intelligence is expected to carry out a lot of clever tasks—like speech recognition, language interpretation, dynamic, and so on—without the need for human intervention. The Internet of Things (IoT), on the other hand, connects a number of networked devices to a framework that transfers data. IoT gadgets have incorporated themselves into our daily lives and aim to increase our level of comfort. These devices rely on web organisation and generate staggering amounts of information that are relevant to client behaviour, their patterns, unique information, etc. and thus cannot be disregarded. Nevertheless, a lot of projects don't know how to store and transfer such enormous amounts of data. The capabilities and growth of IoT are being hampered by this. In this situation, artificial intelligence can be of enormous assistance in gathering the data deluge that the Internet of Things devices have created. It permits data inspection and excellent output from it. [4] [5]

BENEFITS OF AI-POWERED IOT

• Preventing unexpected downtime — Using analysis to predict hardware failure in advance to arrange coordinated support methods, also known as Predictive Maintenance, can help mitigate the detrimental cost effects of unscheduled personal time.

• Increasing operative efficacy – Artificial intelligence models can foresee working conditions and identify boundaries that should be balanced on the fly to maintain optimal outcomes, which will assist increase operating efficacy.

• Enabling better products and services – using individual language processing to replace text, AI-controlled automata, and Navy management are just a few of the ways artificial intelligence will assist in enhancing the existing goods.

• Improving risk management – Together with AI and IoT, a few proposals are helping organisations understand and predict a range of risks as well as computerise quick response [6][7]. IoT and artificial intelligence integration is seen in Figure 3.

Figure 3: IoT and artificial intelligence integration

ADAPTIVE AI-ENABLED IOT APPLICATIONS

The IoT hardware includes mobile devices in a big way. There are several IoT devices that remotely send and receive data. By developing an explicit AI chip that would offer mobile

devices access to AI, human-made intelligence is elevated to a crucial role. Sensors and automata may capture every step of the development process for a firm, from the structure to the delivery. Then, artificial intelligence would have a reason to care about them, allowing it to create 3D maps, eliminate outlines, and replicate development plans. These are a few examples of how the commercial world is changing as AI and IoT are introduced.

1. Safety devices: For opening doors and gear employments, AI might be used to determine typical admission instances of different reps or professions and degrees of employees, providing careful consideration to forthcoming office designs and perhaps differentiating questionable activity [8].

2. Sensitivity analysis: In China, it has been established that homerooms should be filtered once every 30 seconds. The computation can determine students' emotions (happy, sad, weary, etc.), as well as their behaviour (perusing, composing, lifting a hand, and so on). The cameras gather the data in this case, while local people handle the photo recognition stage. [9]

3. Create smart households: by automating the home Several appliances and systems, including as the fridge, air conditioner, cooker, water flexibly, electric pleasantly, and security systems equipped with sensors in a home demonstrate like smart devices and are connected to Internet of Things apps. Here, artificial intelligence takes the shape of information gathering, research, and dynamic frameworks for acting appropriately [10].

4. Smart Cities: Like the clever house concept, the brilliant city uses a combination of IoT and AI advancements to operate at a vast scale. The two developments assist with water management, waste management, waste framework, transportation, stopping, electric networks, street and rail management, wellness and security components of the entire city, and so forth [11].

5. Healthcare sector: Medical services generate a significant amount of useful information, and wearables and IoT together account for a sizable volume. Computer-based intelligence provides in-depth understanding of the information and moreover provides assistance to HR executives, continual responses, stock management, unified drug store administrations, projections, and recommendations. [12].

REAL-WORLD CASE STUDIES

Artificial intelligence in the Internet of Things is, for the most part, a revolutionary idea, but it has only lately been effectively used in certain practical applications.

Autonomous Vehicles: In the context of the current reality, self-driving cars have a vast range and a lot of potential. The latest developments in AI and IoT are used in self-driving cars. Although they are still in the experimental phase, these cars represent one of the more straightforward IoT developments.

Wild Track: Conservation of Endangered Species: Numerous species of animals that are either endangered or on the verge of extinction worldwide. Also, it is distressing and risky to

monitor these creatures using standard methods, which include lapels. The FIT technique is used in IoT and AI computations to identify a creature's species, individual, age, and sex from its distinctive impression. At that time, it will be possible to utilise this data to show how various species at risk of extinction have plans related to animal turns of events, human species, etc.

A smart thermostat: The Nest Labs Smart Thermostat, which uses IoT to enable temperature checking and control from anywhere with PDA connectivity (everything is getting smarter these days!), leverages smart technology. One of the main factors contributing to its popularity is that it is also quite easy to use (beside AI and IoT clearly).

The Nest Labs interior controller has a sizable capability that is accepted as human made. It is employed to understand the temperature inclinations of the clients and, in addition, their detailed strategy. At that time, it adjusts to the perfect temperature and furthermore the most outstanding imperativeness reserves [13][14][15].

AI AND IOT FOR COVID TREATMENT IN HEALTHCARE

Since the initial report of Coronavirus Disease 2019 (COVID-19) was released in Wuhan, China in December 2019, it has had an impact on more than 200 countries and regions worldwide. Innovation and science are playing a crucial role in this perplexing conflict. For instance, China focused on computerized reasoning right away when it began responding to the outbreak, using facial recognition cameras to track infected patients with movement history, robots to deliver food and medications, automatons to clean up open spaces, and sound communications to the general public urging them to stay at home.

The search for new particles while in route to locate assistance for COVID-19 has made extensive use of artificial intelligence. In addition to certain software engineering analysts focusing on finding the irresistible patients using clinical image preparation like X-beams and CT filters, many medical professionals are using AI to discover novel treatments and drugs for the repair [16]. In any case, programming that is created using computer-based intelligence mimics checking armbands and aids in the categorization of individuals into groups that can circumvent the isolation rule. For the purpose of identifying fever-stricken and infected patients, modern smartphones and AI-enhanced warm cameras are also being used [17].

Countries like Taiwan disregarded COVID patients based on their mobility history and side effects by combining contributions from the migration and customs data collection with public clinical protection information [18, 19]. AI is used to identify, monitor, and predict flare-ups, as well as to assist in infection diagnosis. It is used for processing claims for medical care. In addition to sterilising public areas, automatons and robots are used to transport food and medical supplies. Super PCs are being used in conjunction with artificial intelligence to help create COVID antibodies and pharmaceuticals [20,21].

The focus of the present inquiry is on how using artificial intelligence may help the fight against the coronavirus plague. It provides a thorough analysis of the cutting-edge strategies

employed to lessen and mask the significant impact of the upheaval. The goal of the current inquiry is to not only assess the effectiveness of the tactics that are shown, but also to advocate for their continued use. This essay explores AI's potential applications and offers a basic vision of how contemporary innovation may combat the COVID-19 epidemic.

MODERN TECHNOLOGY'S ROLE IN BATTLING COVID-19

Innovation refers to tactics, frameworks, and tools that are the postponed result of using logical data for acceptable ends. Applications for machine learning, natural language processing, and computer vision can all be considered forms of artificial consciousness. These capabilities teach Computers how to configure, represent, and predict using massive data-based models. AI heavily emphasises patient identification and infection detection, clinical imaging assessment, disease monitoring, and its forecast in order to combat Covid. On the other hand, it also discusses alerting, cultivating awareness, and social control online.

Patient's perspective: Open clinical structures face serious issues as a result of the COVID-19 outbreak. The severity of the patient determines how much care is needed given the restricted clinical resources. Despite the fact that many light outpatients swiftly progressed to the real or basic stage, it is crucial to recall them early and provide lucky therapy for improving the course of treatment and lowering mortality. For analysing, predicting, and treating COVID-19 pollutions, as well as assisting in the oversight of budgetary effects, computer-based intelligence limits can be very helpful. The majority of clinical applications of artificial intelligence to the COVID-19 response up until this point have been centred on clinical imaging-based findings. The nature of the current diagnostic methods has been addressed at the fundamental form of the disease.

Radiography pictures used in diagnosis: With the quick and accurate examination of COVID-19, survival can be preserved, the extent of the illness can be examined, and enormous knowledge may be generated from Artificial Intelligence models. Researchers experimenting with AI applications show that they can speed up and reduce the cost of making a diagnosis for radiotherapists compared to using COVID standard testing. Because of this, experts can use X-beams much as CT filters [24].

Disease surveillance: AI may be used to track the COVID-19 epidemic with time and location. According to ongoing disclosures, COVID-19 exhibits respiratory symptoms that are distinct from the infrequent flu and common cold, particularly tachypnea (rapid breathing) [25]. One initial-request symptom that may contribute to the extensive airing of developing patients is the degree of tachypnea [26]. It has been suggested that PDAs with integrated sensors might be used to detect COVID-19 symptoms or that telephone-based research could be used to station people who pose a high risk of harm based on their replies to crucial questions [27].

Benefits of IoT in combating COVID-19 pandemic: The invention of the Internet of Things ensures that everyone who has been harmed by this illness has been separated. It is advantageous for a suitable witnessing framework during isolation. The Internet of Things

techniques are used to efficiently monitor all patients who pose a high risk. This update is used to estimate problems such as glucose levels, circulatory strain, and heart infections biometrically [28].

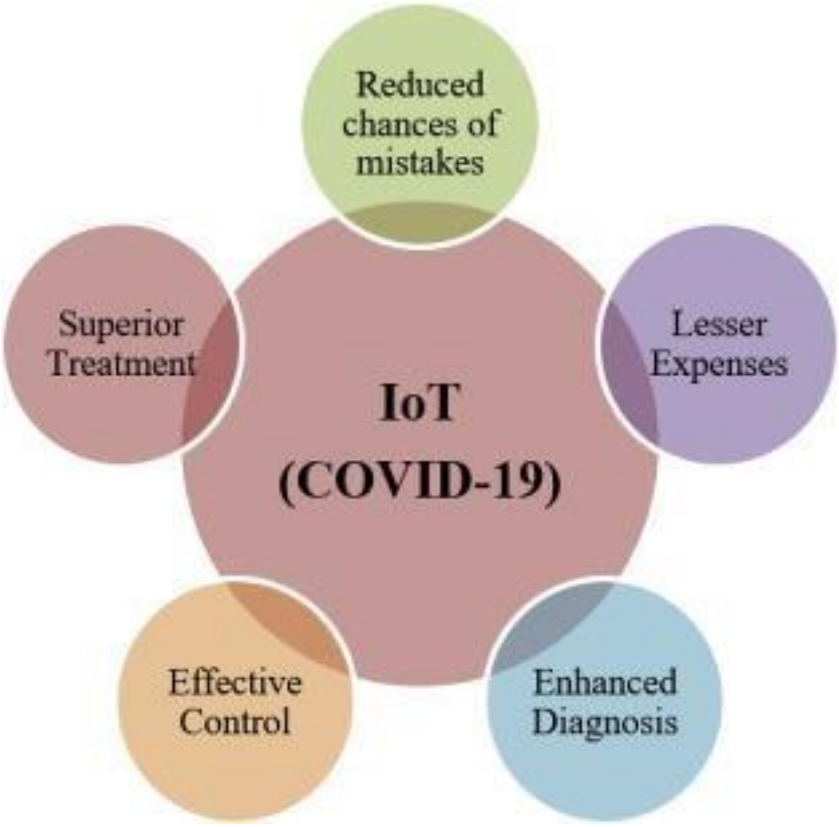


Figure 4. The main benefits of adopting IoT to combat the COVID-19 epidemic.

IoT is an unique strategy to combat the COVID-19 epidemic and can alleviate significant difficulties during a lockdown situation. This innovation is helpful for securing the patient's personal information and other crucial data [30]. The main benefits of deploying IoT to combat the COVID-19 Pandemic are shown in Figure 4.

IOT-BASED COGNITION AND SOCIAL CONTROL

A framework for COVID-19 identification utilising information obtained from mobile phones, gadgets such as cameras, amplifiers, medical equipment, and inertial sensors is proposed[29]. The hack type identification system, however, uses steady data obtained from a mobile phone amplifier [30]. This information is vital for artificial intelligence (AI) systems to comprehend and foresee the sinister danger that each individual poses. As a result, it is helpful in the early detection of high-risk equipment for specific purposes, thereby limiting the spread of disease to helpless populations [31]. A few automatons are employed to follow people, albeit they are not nearly as effective as the facemasks now in use. Other automatons are utilised to share information with larger groups and, in addition, to sanitise public areas.

CONCLUSION

Artificial intelligence and the Internet of Things are incredible and help to enhance commercials in spectacular ways. Moreover, combining these two progressions will

encourage daring to achieve substantially more dramatic automated change. There are a huge number of areas that can benefit from the benefits of combining the two developments. Integrating AI and IoT is no walk in the park for the gaming industry; not only does it call for deep theory, but it also necessitates new skills and dominance. But, when combined, both of these innovative developments greatly help associations increase their edge and profit margin. Researchers are examining every option that may be used to tackle the COVID epidemic, and CurrentKnowledge discusses one exciting route. As progress creeps incrementally into our lives with various victories, they have also added in aiding individuals in these incredible battles against COVID-19.

In order to combat the COVID-19 epidemic, IoT offers a broad, streamlined association to healthcare administrations. All medical devices are connected to the internet, which allows for communication with the clinical personnel in any basic circumstance. Using nearby connected tele-devices, spoiled cases may be handled effectively in an inaccessible area.

An seemingly divine method to cover the debased patient is mimicked insight near to IoT. This innovation helps to retain superior oversight with consistent information while taking clinical considerations. Researchers, officials, the government, and academics can create a better place to combat this ailment with correct implementation of this improvement.

The survey's findings will be used to describe how AI combined with IoT has a significant impact on this epidemic. Several businesses, like the automotive and industrial sectors, have found that the combination of these two domains works well thus far. In the modern day, it focuses on the medical industry as well, and during this pandemic it aids in locating the COVID positive cases and their contacts. Moreover, it focuses on tracking and diagnosing diseases. Integration of AI and IoT at the onset

REFERENCE

[1] Chirag Thumar,2017, What is the chemistry between IoT and AI
[2] Forbes, 2017, Based on a 2017 Forbes Insights survey of 502 global executives
[3] https://www.sas.com/en_us/insights/analytics/what-is-artificial-intelligence.html
[4] Chuck Martin, 2018, What Are the Emerging Trends in AI in 2018?
[5] Susanne Hupfer, 2017, AI is the Future of IoT,
[6] Anand Rao, Joseph Voyles and Pia Ramchandani, 2017, Top 10 artificial intelligence (AI) technology trends
[7] Newgenapps, 2018, 12 IoT Trends: Experts Answering How IoT Will Evolve by 2020 [8]Anurag Srivastava, 2018, IoT With the AI: Why Do We Need This?
[8] Marga Verdú, 2018, Artificial Intelligence makes the IoT smarter and more efficient, IoT Solutions World Congress.
[9] Sunil Kappal, 2017, The Biggest Challenges in Implementing AI.
[10] Saviantconsulting, 2018, 6 key IoT Implementation Challenges for Enterprises to consider.
[11] Indatalabs, 2017, 3 Major Problems of Artificial Intelligence Implementation into Commercial Projects.
[12] https://www.britannica.com/technology/artificial-intelligence
[13] https://www.sas.com/en_us/insights/analytics/what-is-artificial-intelligence.html
[14] https://towardsdatascience.com/the-power-of-combining-ai-and-iot-4db98ac9f252
[15] Nguyen T T,Waurn G,Campus P,2020,Artificial intelligence in the battle against coronavirus : A survey and future research directions(2020).
[16] Maghdid H S,Ghafoor K Z,Sadiq A S,Curran K,Rabie K,2020,A novel AI-enabled framework to diagnose coronavirus COVID 19 using smartphone embedded sensors: design study,1-5
[17] Wang C J,New T,Sun F,2020, Response to COVID-19 in Taiwan big data analytics, new technology, and proactive testing,1-2.

[18] Ali Narin, Ceren Kaya ZP, Automatic detection of coronavirus disease (COVID-19) using X-ray images and deep convolutional neural networks.
[19] Wang S,Kang B,Ma J,2020A deep learning algorithm using CT images to screen for Corona VirusDisease (COVID-19) (2020),1-28.
[20] Jin C,Chen W,Cao Y,Xu Z,Zhang X,Deng L,2020,Development and evaluation of an AI system for COVID-19 diagnosis,1-23.
[21] Cascella M,Rajnik M,Cuomo A,Dulebohn S C,Di Napoli R,2020,Features, evaluation and treatment coronavirus (COVID-19).
[22] Wang Y,Hu M,Li Q,Zhang X,Zhai G,Yao N,2020,Abnormal respiratory patterns classifier may contribute to large-scale screening of people infected with COVID-19 in an accurate and unobtrusive manner.
[23] Rao S R S,Vazquez J A ,2020, Identification of COVID-19 can be quicker through artificial intelligence framework using a mobile phone-based survey in the populations when cities/towns are under quarantine Infect Contor Hosp Epidemiol,1400.
[24] Allam Z,Jones D S,2020, On the coronavirus (COVID-19) outbreak and the smart city network: universal data sharing standards coupled with artificial intelligence (AI) to benefit urban health monitoring and management,Healthcare, 8 ,46-48.
[25] Maddah E, Beigzadeh B, 2020, Use of a smartphone thermometer to monitor thermal conductivity changes in diabetic foot ulcers: a pilot study J Wound Care, 29,61-66.
[26] Nemati E, Rahman M M, Nathan V, Vatanparvar K,Kuang J,2019,A comprehensive approach for cough type detection,Proc - 4th IEEE/ACM Conf Connect Heal Appl Syst Eng Technol CHASE,15-16.
[27] Allam Z, Jones D S,2020,On the coronavirus (COVID-19) outbreak and the smart city network: universal data sharing standards coupled with artificial intelligence (AI) to benefit urban health monitoring and management Healthcare,46.

CHAPTER-3.5

Smart Grid Energy Management System

Priyanka Chauhan, Assistant Professor
Electrical Engineering Department, JBIT Dehradun
priyanka.chauhan529@gmail.com

Abstract-*The integration of highly fluctuating distributed generation (such as PVs, wind turbines, electric vehicles, and energy storage systems) jeopardises the stability of the power and distribution systems. The main reason is that the power ratio between supply and demand may not be balanced. An excess of power generation or consumption may disrupt the network and cause severe problems such as voltage drop (or) rise, and, in extreme cases, blackouts. Energy management systems are used to maintain an efficient balance between supply and demand, as well as to reduce peak load during unexpected periods. Energy management can be divided into two broad categories. The first is on the supplier's side, such as an electric utility, where some generators are turned on and off in response to fluctuations in load demand. The second category is on the consumer side, also known as demand-side management. In demand-side management, consumers manage their energy consumption so that they can manage with the available power from the generation side. The primary goal of an energy management system is to reduce the cost of operation and consumption, thereby reducing energy losses and increasing network reliability. The primary goal of employing energy management is to reduce the cost of operation and consumption, as well as to reduce energy losses and increase network reliability. There are numerous barriers and limitations in energy management. It does, however, have a promising future, with most current researchers focusing on developing sophisticated algorithms and models to better manage energy on the power grid.*

INTRODUCTION

The increased use of available energy resources, as well as improved security and access to these resources, is one of the major challenges that society faces, particularly in this global economy. In addition, existing energy resources must be prioritised, and resource management must be efficient. Following that, the construction of power plants using conventional energy resources. Proper distribution and utilisation of renewable energy resources should be implemented. Even though renewable energy sources require significant infrastructure and initial investment to connect to the grid, once connected to the grid and the necessary synchronisation has been completed, expensive transmission can be performed, and it can also reduce transmission and distribution (T&D) losses, primarily ('Hysteresis And Eddy Currents'). So, the better way to overcome this potential distribution system barrier is to join the system approach, which views the generation and distribution details associated with the loads as a subsystem or a "Micro Grid."

The economic downturn, new technological innovations, and environmental incentives are all altering the face of electricity generation and transmission. Centralized because of the loss of traditional economies of scale, generating facilities are giving way to smaller, more distributed generations. According to research scholars and ongoing studies, the interaction between the smart grid and the individual interaction with the user will change dramatically, and Demand Side Management (DSM) will play an important role. The primary goal of this

paper is to review previous work by various research scholars and to provide consolidated information for management objectives in smart system management, such as improving energy efficiency, profiling demand, maximising utility, reducing cost, and emission control. We investigate the possibility of integrating home and building energy management systems such as solar PV technology and energy storage with a microgrid. Microgrid Energy Management System (MG-EMS) prototype, which includes numerous software applications for managing sensing data and managing load and generation. To upgrade a microgrid from a basic grid to a full-fledged smart grid, HEMS, BEMS, renewable energy resources such as PV, and BESS can be integrated from one type of microgrid to another.

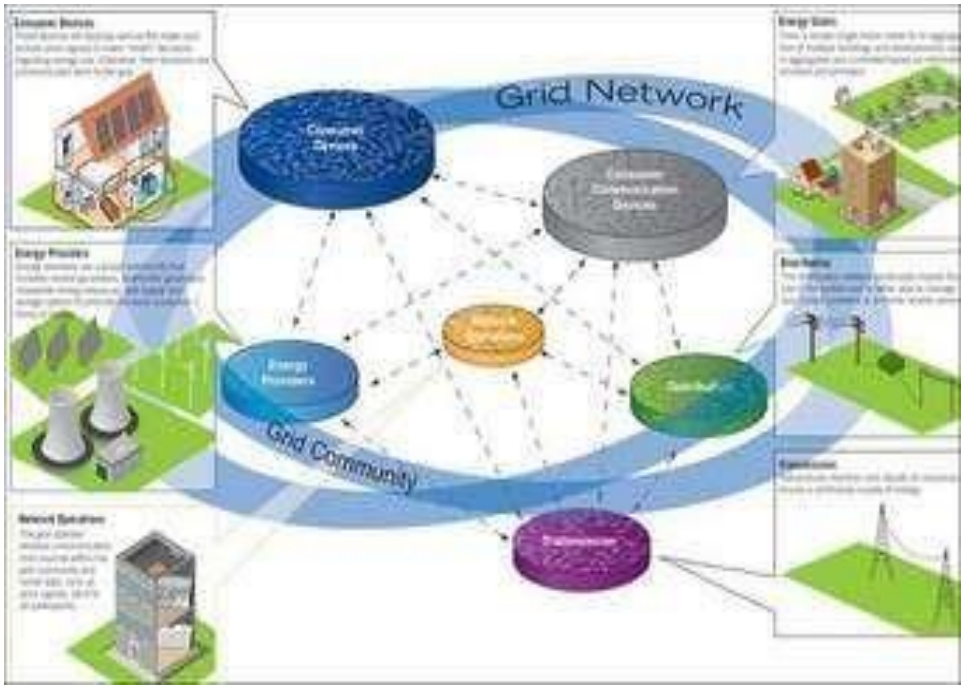


Figure 1: A view of a grid connected to a network system.

ENERGY MANAGEMENT SYSTEM

The active elements of the power system require new technology as well as new control methods in order to achieve control on various interconnected elements to the grid, optimise the active elements, and manage the entire electrical system.

The system's main components are:

• Remote Terminal Unit

• Load Forecast System

• Supervisory Control and Data Acquisition (SCADA)

• Remote Sensing Terminal Unit; • Smart Energy Management System.

The SCADA (Supervisory Control and Data Acquisition) system transmits data to the Smart energy management system to measure data collected by remote terminal units placed at strategic locations throughout the grid.

To access the grid and become synchronised, we need complete control of the grid, as well as complete information about the state of the network, such as current and voltage profiles flowing at each node (or) branch. After learning all of the parameters of the grid, the Electricity Board (or) State Board has set certain targets and demands that must be met... To meet these requirements, a set of methods, mathematical rules, and procedures are devised.

Furthermore, as load demand increases and voltage profile estimations fall short of expectations, adequate monitoring systems and metre infrastructures, as well as wireless/wired automatic metering systems (Smart Meters), are required to obtain an accurate state. Optimising, continuous monitoring, and control of smart grid performance are entrusted to a hardware/software application known as a "Smart Energy Management system." After taking readings and analyzing data from SCADA, the necessary optimisations and steps are taken to achieve the optimal state of the Smart Grid.

When the grid reaches an optimal state, a combination of variables, including the reference values of reactive and active power, is used to transfer power to the OLTC of a transformer in a nearby sub-station.

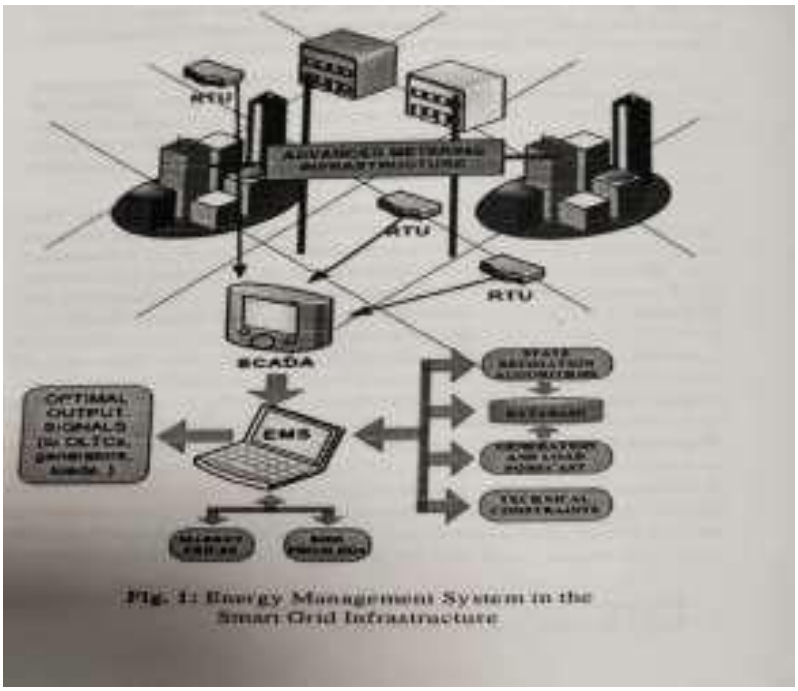


Figure 2: Smart grid Infrastructure Energy Management System

WHY IS ENERGY MANAGEMENT ESSENTIAL?

The integration of highly fluctuating disturbances in generation (such as PVs, wind turbines, electric vehicles, and energy storage systems) had put the power generation and distribution system's stability at risk. The main reason for this is that the power supply-to-demand ratio may be unbalanced, and excess/shortage in power generation or consumption may result in severe problems such as voltage drop/rise, and in severe conditions, the entire day is blackout. Energy management systems are used to efficiently maintain the supply-demand balance and to reduce peak load during unexpected periods. Energy management can be

divided into two broad categories. The first is on the supplier's side, such as an electric utility, where some generators are turned on and off in response to fluctuations in load demand. The second category is on the consumer side, also known as demand-side management.

Consumers will manage their energy consumption in demand-side management so that they can manage with the available power from the generation side. The primary goal of an energy management system is to reduce the cost of operation and consumption in order to reduce energy losses and increase network reliability.Many barriers and limitations can exist in energy management. However, it has a promising future, with current researchers focusing on developing sophisticated algorithms and numerous models to better manage energy on the grid.

In this vast world where energy demand is increasing, power generation should increase to meet peak load demands and user needs while also improving their daily lives. However, the number of consumers is growing every day, and the unpredictability of electric load and power demand may pose challenges to electric utilities and system operators. High peak demand is likely to occur in many problems, posing a threat to the system's functionality.

To address this issue, the electric utility and system management have two options:

The first solution is as follows:

• Expand the network's size and dimensions, which is costly and time-consuming to implement.

• Using energy management to reduce the likelihood of high peak demand during peak hours.

The second option appears more reasonable: However, the solution necessitates more sophisticated algorithms and energy-management methods. For a variety of reasons, energy management is regarded as a better and smarter method:

• It is automated and does not require direct human intervention

• It provides accurate results and predictions

• It assists in optimizing the functionality of its generation units and lowering generation costs

• It assists the system in operating in such a way those energy losses of the network and transmission lines are reduced, potentially lowering indirect distribution electricity costs dramatically

• It assists end-users in better managing their load demand and lowering indirect distribution electricity costs.

• It improves energy efficiency.

• It conserves resources.

• It helps to reduce pollution and protect the environment.

RESPONSE TO CUSTOMER LOAD

The magnitude and speed of the load response can be used to characterize customer load demand response. This is true for dynamic pricing as well as demand response signaling. Load performance can be classified into four categories based on how it is used. Each category is described below; each category impacts the client differently and has a unique feedback loop dynamics. All of the demand response applications mentioned are best served by systems with large energy storage capacities.

CATEGORY 1: SOFT DEMAND RESPONSE

This response period is often required in soft demand response, which is more flexible and can vary from hour to hour and day to day. Soft demand response events are frequently targeted to the daily power consumption to macro cycle, which is frequently driven by higher power consumption during the day, followed by a decrease in nighttime usage. Energy conservation can usually be planned and scheduled ahead of time.

Load shedding and load shifting are two load response time strategies. Load shedding entails reducing equipment that is not mission critical, whereas load shifting is the rescheduling of energy-intensive operations over different time intervals. This encompasses both production lines and equipment processing.

The following components are commonly restricted in equipment:

- External and internal lighting, including parking and lot lighting
- External water fixture
- Anti-sweat heaters
- Cooling system
- Defrosted elements
- Motors
- Elevators and escalators
- Irrigation pump sets
- HVAC (Heat, Ventilation, and Air Conditioning System)
- Pool pump and heater sets
- Refrigerators
- Water heating system

This system's load response time can vary from second to second and hour to hour. Longer response times can be accommodated using a strategy known as pre-ramp down control strategy, whereas equipment with shorter response times can be actuated directly.

CATEGORY 2: FIRM DEMAND RESPONSE

The required firm demand response time ranges from five (5) minutes to ten (10) minutes with this response time. In the markets, this corresponds to ten-minute wholesale ancillary. Firm demand response can help the grid balancing authority balance a reduction in power generation capacity with a compensating reduction in load. This category is appropriate for balancing variables in renewable generation with adequate inertia, capacity, or load prediction.

Examples of typical firm demand curtailment include:

• Lighting both externally and internally, including parking and lot lighting • Pool pumps

• Air handlers • Elevators and escalators • Irrigation pumps • Motors • Outside signage

CATEGORY 3: DEMAND RESPONSE IN NEAR REAL TIME

Near real-time demand response necessitates response times ranging from one (1) minute to five (5) minutes. As a result, these are appropriate for fast-response ancillary energy markets powered by a significant amount of variable renewable generation.

Only these pieces of equipment can perform high-speed ramp down and participate in near real-time demand response. External and internal lighting, including parking lot lighting, are typical examples of real-time response.

• Outside water fixtures • Air handlers • Irrigation pumps • Motors • Outside signage • Pool pumps

CATEGORY 4: REAL-TIME DEMAND RESPONSE

Response time for real-time demand response ranges from one (1) second to one (1) minute. Power frequency and load regulation, as well as emergency response to grid faults, are among these applications. Real-time response necessitates very fast equipment and the ability to shut down, as provided by motor-driven equipment or lightning. In general, the number of cases in which a customer can react reduces the movement from category 1 to category 4. To reduce the response time from five (5) minutes to one (1) minute, the decision-making processes involved in load shedding, shifting, or shaping must be automated and streamlined in order to provide a high degree of determinism and system reliability.

Demand response signals will include information from both discrete and continuous signals. Discrete signal information is frequently presented in the form of dispatch triggers that can initiate action. Continuous signal data will be represented as value matrices, such as dynamic pricing, and will be fed into decision-making algorithms.

SMART GRID FEEDBACK LOOPS

Bringing customers further and further into the energy loop is another important claim of smart grid that requires more investigation.

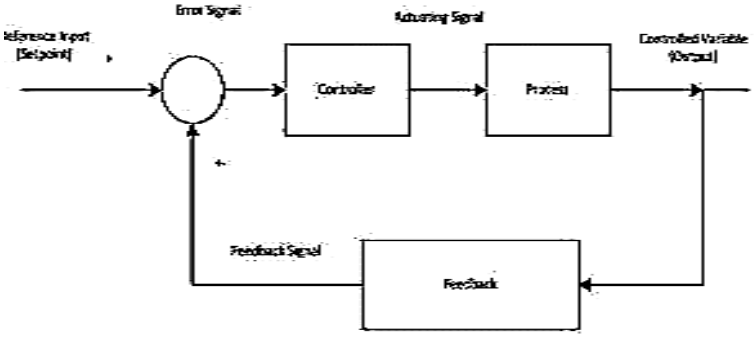


Fig. Balancing Feedback Loop

A smart grid is a system of systems that are linked together by large, wide-area feedback loops. These feedback loops are the fundamental behaviour of a system of systems' operating unit. They can cause the system to expand or contract.

Feedback loops can return an amplified portion of the output signal feedback around the input loop, where it can either add or subtract from the input signal. This simple basic structure serves as the foundation for automatic control theory, which is widely used in a variety of domains such as manufacturing, automation, aircraft control, and automotive systems.

A negative or balancing feedback loop is one in which the fed back signal tends to subtract from, or offset, the input signal and decrease the output. A positive or reinforcing loop occurs when the fed back signal adds to the input signal. The system and feedback loop have a transfer function that relates the output signal to the input signal and is usually expressed in terms of Laplace transforms. The loop's behaviour when a specific input signal is applied can then be determined. The transfer function has a solution known as poles and zeros, which either drives the loop towards oscillation or causes it to become zero. If the feedback loop is a balancing loop, both conditions are negative.

The home thermostat is an example of a simple on-and-off balancing loop. The desired balance point is almost as close to the temperature setpoint as it can be. The feedback signal is equal to the temperature in the room. When the temperature in the room reaches a certain setpoint, the heater is turned off until the temperature falls below the setpoint. This digital loop will inherently oscillate, relying on the room's high capacity and slow response to achieve the required acceptable results.

A reinforcing feedback loop will amplify the output feedback signal by stacking on top of itself, resulting in exponential growth or collapse. The amount of feedback or gain can determine the rate of growth.

The fundamental property of feedback loops is that they oscillate in a proportional manner. This oscillation is caused by loop time delays, or peak time, which causes feedback signals to phase shift. A negative feedback signal becomes a positive feedback signal if the resulting phase shift is equal to 180 degrees. Balancing loops become reinforcing loops as a result, and if the strength of the feedback is equal or sufficient (product of loop gains >= 1.0), the signal becomes unstable and oscillates. A sufficient upfront system design is required to ensure that this condition does not reoccur.

TRENDS IN SMART GRID TECHNOLOGY

Smart Grid technology has enabled two technologies that have a direct impact on the dynamic management of energy systems. These are;

1) micro grids and generation of disturbed energy &

2) Transactive energy

The grid provides electrical energy to consumers, but only a portion of the power generated on-site. The generation distribution allows more facilities to generate on-site energy and

become self-contained microgrids connected to the electrical system. These micro grids will benefit both the electrical distribution system and the facility, helping to optimise the system-wide generation and consumption of energy. Microgrids are grid-connected, self-contained energy systems that can generate and consume on-site power. The system can either import or export power to the grid, and it has the ability to disconnect from the grid. The decision-making process is required to determine the mode of operation, which is taken into account for both local and grid operations. When the external power cost is relatively high, a strategy based on exporting excess power generation and minimising imported power would be the best course of action to take. If the cost of external power falls, the cost of self-generated power will fall as well. Increasing power imported from the grid while decreasing on-site generation would be an excellent strategy. If there is an emergency or a fault condition on the external grid, the microgrid load can be curtailed or disconnected from the grid and then reconnected when all conditions allow. Today, centralised power grid control is giving way to distribution control, with more localised and autonomous decision makers. These decision-makers and "software agents" will collaborate with other agents to optimise the energy consumption of connected devices and systems. These interactions, known as transactive energy, will take the form of transactions with other systems based on the local economy and context. A small microgrid is one type of autonomous system, but as transactions involving the buying, selling, or renting of retail power become more granular, decision making will become more granular. Huge energy transactions can take place between microgrid components and between microgrids and even smaller self-contained energy systems like "nano grids."

Transactive energy has no effect on the requirement that the power grid operate in a stable state of equilibrium, with supply nearly equaling demand usage. Through positive reinforcing in feedback cycles, autonomous market-driven behaviour will produce system oscillations and instabilities. This behaviour can be extremely beneficial for grid-scale operations, but it must be managed proactively to avoid negative consequences.

With variable renewable energy generation and an increase in the use of value-based economic or market-derived signals, such as dynamic pricing, to modulate energy consumption, the power grid's dynamics will increase. The value-based signal needed to be injected into the customer's feedback loop in order to maintain the required stability. The new techniques must be implemented in order to allow for the operating range in market activity.

These techniques must limit not only the acceptable operating range of things, but also the rate of change of activity and duration.

RESULT

The Smart Grid enables customers to dynamically manage power usage based on electrical grid operating conditions and the country's economy. Integration, grid stability, and reliability are all improved, while the customer benefits from lower costs and more dependable electricity.

The use of compensation and negative feedback loops, which leverage customer demand to offset variation in power supply, is an important method for balancing the grid.

Implementing energy management will be crucial in the future. Despite the fact that transitioning from a conventional grid to a smarter grid takes time and money, energy management plays a critical role in increasing grid efficiency and the reliability of power and distribution systems.

The Energy management system enables a consumer to reduce their electricity bill cost by approximately 20 to 30%, which is significant and beneficial over time. It is recommended for a better future to have some standards and a set of rules and regulations requiring users to install energy management systems to reduce power consumption as much as possible.

REFERENCES

[1] Gujar, Mukesh, Amitava Datta, and Parimita Mohanty. "Smart Mini Grid: An innovative distributed generation-based energy system." Innovative Smart Grid Technologies-Asia (ISGT Asia), 2013 IEEE. IEEE, 2013.

[2] Yoshio Ebata, Hideki Hayashi Yoshiaki Hasegawa Satoshi Komatsu Kuniaki Suzuki, ―Development of the Intranet-Based SCADA (supervisory control and data acquisition system for power system)‖, 2000, pp.5

[3] Farrokh Rahimi, Senior Member, IEEE and Ali Ipakchi, Senior Member, IEEE ―Overview of Demand Response under the Smart Grid and Market Paradigms‖ 2010 IEEE.

[4] Gungor, V. Cagri, et al. "A survey on smart grid potential applications and communication requirements. "Industrial Informatics, IEEE Transactions on 9.1 (2013)

[5] Tushar, Wayes, et al. "Three-party energy management with distributed energy resources in smart grid." Industrial Electronics, IEEE Transactions on 62.4 (2015): 2487-2498·

[6] Shivander Mehta and arhad Ilahi Bakhsh “Efficient Energy Management and Grid Interconnection of Solar PV System

[7] Hanna Talei, D. Benhaddou, Mohamed Essaaidi “Smart campus energy management system advantages architectures and the impact of using IOT” Introduction, “Energy Management Systems in Microgrid Operations.pdf,” Electr. J., vol. 25, no. 8, 2012.

CHAPTER-3.6

Implementing Energy-Saving Strategies and Renewable Energy Sources In Buildings Using Big Data Technologies

Deepak Kumar Verma
Assistant Professor, JB Institute of Technology Dehradun Uttarakhand 248197
deepakkumar8290@gmail.com

ABSTRACT: *It is now required for all industrial enterprises to implement energy-saving plans, and enhancing the efficiency of industrial facilities is no longer a matter of prestige. This essay examines the issues with energy management and excessive energy usage that typically occur at pumping stations. An approach has been devised to meet such a water demand while taking into account having optimal flow, lowest consumption, and with maximum efficiency. It is based on the results of energy auditing and energy performance of the most energy-consuming equipment. The findings indicated that this pumping station has the potential to save 1 313MWh of energy, or 8.30% of the average monthly electrical energy use of 15 422MWh. The advantages of implementing water and electrical energy efficiency measures are significant, both in terms of cost and energy savings. usage and with optimum efficiency.*

Keywords- - big data; energy efficiency of buildings; energy saving measures energy consumption; regression analysis; forecasting method, renewable energy sources.

INTRODUCTION

A near-total dependency is what defines the Moroccan energy context. Given the rising demand for energy that comes along with the large projects of the Kingdom, Morocco is a country that imports energy to the tune of 95% of its annual consumption, and its energy bill is rising. Numerous businesses are concerned about this issue and want to comply with the guidelines established by the energy efficiency regulation No. 47-09. The objectives of Law No. 47-09 are to use energy sources more efficiently, prevent waste, lessen the impact of energy expenses on the national economy, and promote sustainable development. [1]. Its execution is primarily based on the principles of required energy audits, technical control, energy impact studies, and efficiency criteria. Additionally, it seeks to include energy-efficiency strategies in all sartorial growth plans, enticing commercial enterprises to expand their use of energy audits. Global energy consumption is rising, and if petrol emissions were to continue rising at their current rate or greater, global warming would increase [2]. Saving energy entails protecting priceless resources and, of course, achieving substantial financial savings that may be put towards cost management and surviving the whims of the market [3–4].

On June 15, 2011, the international standard ISO 50001 was released [5]. The objective of this EMS standard is to enhance the energy performance of any kind of company. According to the International Energy Agency, it might affect 60% of the world's energy demand. Organizations can use a variety of management techniques under ISO 50001 to boost energy performance, cut costs, and promote efficiency [6]. To encourage energy efficiency, numerous nations have implemented effective management of electric energy regulation. In

order to create and deploy EEMs to decrease energy losses, energy expenses, and assure the efficient use of electrical energy, they are compel big commercial and industrial electrical users to control their equipment [7-8]. This essay is organized around four basic axes, which are broken down into the following sections.

- The work's overall context and the chosen approach are presented in the first section.
- The analysis of statistical data from a typical site, energy diagnostics, detection of anomalies, and mode of management evaluation are all covered in the second section.
- The third section will concentrate on evaluating the energy performance of the equipment that uses the most energy.
- The creation of management and improvement prepositions will make up the fourth

METHODOLOGY

An industry's strengths and deficiencies with regard to energy performance are intended to be highlighted by the energy audit, which serves as a diagnostic [9-10-11]. The goal is to locate energy deposits, decrease energy waste to a minimum or perhaps completely eradicate it [12]. A collection of suggestions for energy, economic, and environmental improvements are put forth following a thorough inventory. The preliminary audit's three primary components are the energy audit of the current state, the in-depth audit's appraisal of energy performance, and the formulation of improvement measures.

Evaluation of the Current Situation (preliminary Audit): In order to quantify the energy consumed by the site and set the threshold of current consumption in the form of energy ratios, the first stage attempts to develop an overall assessment of energy consumption. For this purpose, an analysis of energy bills is required. These ratios will serve as the foundation for the target energy savings percentage. The following information was initially retrieved from the industrial site:

• The last three years' worth of electricity usage.

• Production volumes for the previous three years.

• A site plan and layout for the industrial area.

• Data sheets and catalogues for every piece of industrial gear.

Estimating the deposits of potential energy savings to be realized via the implementation of an energy management programmed requires an examination of the data using regression and correlation of consumption with production.

B. Energy Performance Assessment (detailed audit): This step entails creating a strategy for figuring out and selecting performance indicators as well as establishing the energy balance at each installation site. We use the archive of electric meters to create a distribution of the overall energy consumption in percentages so that we can focus on the items that use the most energy. This distribution enables the identification of the equipment with the highest

energy consumption, which will subsequently be the focus of an in-depth analysis for the creation of improvement activities.

C. Improvement Actions Development: The goal is to create energy-saving initiatives based on three standards:

• Technique.

• Economic.

• Ecological.

As a result, a number of elements must be considered in the evaluation, and the decision-making process is therefore extremely significant.

DIAGNOSIS OF THEEXISTING SITUATION

This audit was carried out in 2017 at typical water pumping stations, which have 15 distinct pump units. In order to determine the energy consumption relative to production, this section analyses the pumping station's inventory and energy usage. It then proceeds to track and evaluate the various consumptions and energy bill metrics. Our system uses 185 056 MWh annually, or 28% of the platform's electrical energy. Since it is obvious that the station in issue consumes a lot of energy, any improvement will reduce the yearly energy bill. The contribution of this station to the overall plant consumption is shown in Figure 1 below.

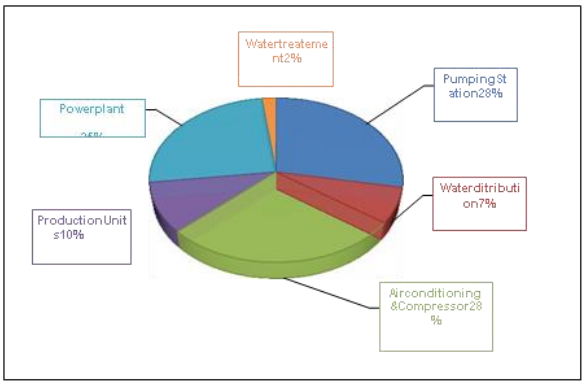


Figure 1 shows how much energy the pumping station uses.

A. Electricity Consumption Distribution at the Pumping Station: According to Figure 2, the motor-pumps account for 80% of the station's energy use. As a result, we are only interested in studying motor pumps.

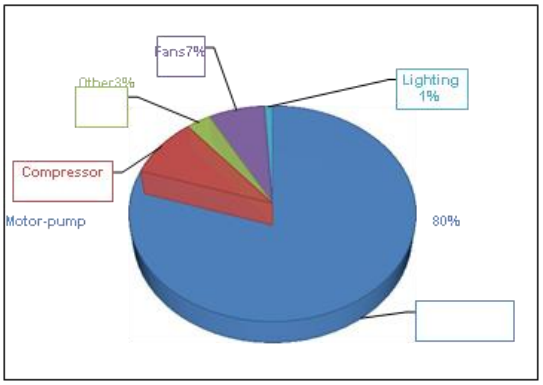


Fig. 2. The pumping station's distribution power consumption

In industrial motor driven systems, pumping systems typically account for 18% of energy usage [13–14].

B. The Mode of Management and Anomalies: By starting or stopping a motor pump in response to consumer and user demand, the seawater pumping system is managed. Following a station inspection, we were able to identify a few faults, including:

• Inexplicable starts and stops of motor pumps that shorten the lifespan of vital equipment.

• Occasionally, the discharged flow exceeds the flow required by the client, resulting in an overflow at the spillway.

• The station's total blackout.

• The regrouping pipe, where the flow of the released water is metered, does not allow for individual motor-pump performance management.

PERFORMANCE EVALUATION MEASURED PARAMETERS

To ensure that the analysis's findings are applicable, the amounts required for the audit must be measured precisely. In this regard, it's critical to precisely describe the technical requirements required to ensure that the measurement companion is neither undersized, which would suggest analysis errors, nor excessive, which would suggest idly spending money, time, and human resources on materials. The two categories of parameters that must be measured are hydraulic measurements and electrical measurements.

A. Hydraulic Measurements: With the aid of calibrated measurement tools, the hydraulic parameters are measured. During the measurement, the system cannot experience any interruptions. These actions will be taken right inside the discharge lines. To acquire the hydraulic data and parameters, the following measurements are required.

• Flow of pump discharge.

• Pressure during suction and discharge

B. Electrical Measurements: Electrical measurements are taken by electrical specialists during routine operations rather than when the pumps are turned on.

• Voltage

• Current

• Power factor

C. Efficiency of the Motor Pump Units: Calculating the pumps' efficiency (p) involves dividing the hydraulic power (Ph) by the absorbed mechanical power (Pm).

$$\eta_p = \frac{P_h}{P_m} \times 100 \qquad (1)$$

It is advised to assess the electromechanical efficiency of the motor-pump because it is challenging to measure the mechanical power separately and then calculate the efficiency of the pump.

The electric power is calculated by the equation (2):

$$P_e = \sqrt{3} \times U \times I \times cos\varphi \qquad (2)$$

Where:

U: the measured voltage (V), I: the measured current (A), Cos φ: power factor.

The electromechanical efficiency corresponds to the efficiency of the motor pump assembly is:

$$\eta_{em} = \frac{P_h}{P_e} \qquad (3)$$

Hydraulic power is calculated using equation (4):

$$P_h = \frac{H_{MT} \times Q \times \rho \times g}{1000} \qquad (4)$$

Where:

Q: flow (m^3 /s).

ρ: density of seawater (Kg /m^3).

g: the acceleration of gravity (m /s^2).

$P_{discharge}$: Discharge pressure (Pa).

$P_{suction}$: Suction pressure (Pa).

H_{MT}: The manometric head of the pump is obtained by:

$$H_{MT} = \frac{P_{discharge} - P_{suction}}{\rho \times g} \qquad (5)$$

D. Specific Consumption: The link between the energy required by the seawater pumping system and the overall amount of water generated and delivered to the customer is represented by specific consumption. As shown below, the precise usage is computed:

$$C_s = \frac{Total\ consumed\ energy\ (KWh)}{Total\ produced\ water\ (m^3)} \qquad (6)$$

The pumping station's precise energy usage ranges from 0.132 to 0.161 KWh/m3, with an average of 0.153 KWh/m3. According to Figure 3 below.

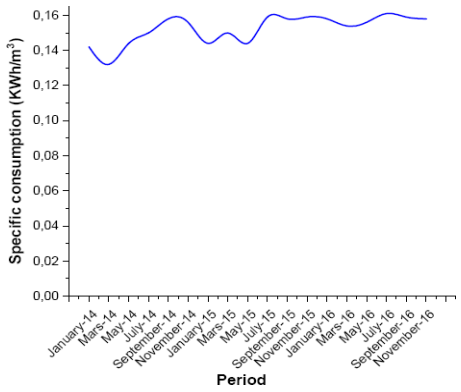


Fig.3. Evolution of specific consumption

Establishment of a management system for the sea water pumping station: We come to the conclusion that the pumping station has the highest consumption point in our research system. It is also notorious for management problems, such as spillway overflows and abrupt motor-pump starts and stops that are not necessary. In order to guarantee the customer's constant supply of seawater while optimizing pumped flow and energy use, we suggest and evaluate a pumping station management system. We have thought about the following theories in order to answer our dilemma.

- Preservation of material flow (no leaking pipes).
- The seal evil is average
- Reliability of data obtained from daily records.
- Price of KWh is 0.7DH.

A. Formulation of the Problem: We utilize the "Microsoft Excel" program to address our issue. We'll be using Excel 2013, the most recent version. To lower the price of energy bills, we work to establish the pumping station's ideal operation. While guaranteeing that the water demand is consistently met and taking into consideration the storage conditions

Table I displays the electromechanical performance calculation findings. It should be noted that the measurements were made over the course of one month, and we used the average value.

Table 1: Calculation of the electromechanical efficiency of motor-pump

Motor-Pump Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Voltage (V)	10200	10100	10100	10100	10100	10100	10100	10100	10100	10100	10100	10100	10100	10100	10100
Current (A)	278	163	319	323	164	278	232	143	296	278	175	240	279	160	333
Power factor	0.78	0.79	0.8	0.79	0.82	0.78	0.82	0.83	0.75	0.76	0.79	0.84	0.77	0.81	0.79
Aspiration pressure (Pa)	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000
Suppression pressure (Pa)	740000	740000	740000	740000	740000	745000	740000	740000	745000	740000	740000	743000	741000	743000	720000
Flow (m^3/h)	16000	8900	18900	18500	8900	16000	13500	8000	14000	14500	8100	13500	16200	9100	19800
Density (Kg/m^3)	1030	1030	1030	1030	1030	1030	1030	1030	1030	1030	1030	1030	1030	1030	1030
Gravity (m/s^2)	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8
Mano metric high (m)	71.33	71.33	71.33	71.33	71.33	71.82	71.33	71.33	71.82	71.33	71.33	71.63	71.43	71.63	69.35
Hydraulic Power (KW)	3200.00	1780.00	3780.00	3700.00	1780.00	3222.22	2700.00	1600.00	2819.45	2900.00	1620.00	2711.25	3244.50	1827.58	3850.00
Electric Power (KW)	3830.78	2252.60	4464.26	4463.74	2352.49	3793.23	3327.91	2076.27	3883.49	3695.96	2418.43	3526.63	3758.06	2267.12	4601.94
Electro Mechanic efficiency (%)	83.53	79.02	84.67	82.89	75.66	84.95	81.13	77.06	72.60	78.46	66.99	76.88	86.33	80.61	83.66

For this purpose, we have categorized the pumps into three pumps that produce 18000 m3/h, seven pumps that produce 15000 m3/h, four pumps that produce 9000 m3/h, and one pump that produces 7500 m3/h. The total number of combinations is equal to:

$$N = \sum_{n_i=1}^{4} 2^{n_i+1} = 2^{3+1} + 2^{7+1} + 2^{4+1} + 2^{1+1} = 308 \quad (7)$$

Where: ($n_1 = 3$, $n_2 = 7$, $n_3 = 4$ and $n_4 = 1$) denoting the number of pumps for the same rate flow.

The flow, power, and efficiency of the various combinations are then calculated. Any combination without a flow in this interval is removed from the calculation to limit the number of combinations: [65000 - 110000] m3/h, the plant's flow rate consumption of sea water in its normal operation. We have 113 combinations left.

$$N_{Sub-combntion} = \prod_{i=1}^{4} C_{n_i}^{m_i} \quad (8)$$

Where:

m_i: number of operating pumps.

n_i: number of pumps with same flow.

$$\begin{cases} n_1 = 3 \\ n_2 = 7 \\ n_3 = 4 \\ n_4 = 1 \end{cases} \quad (9)$$

The second stage, which entails extracting sub-combinations by incorporating the features of each motor-pump unit, is carried out after creating the combinations in accordance with the pumps flow. Each combination has several sub combinations that are determined by cardinality by equation (8).

Equation (8) will be demonstrated using the following example. Let's determine how many sub combinations were drawn from the combination in which the pumps are active: A pump of 9,000 m3/h, a pump of 7,500 m3/h, two pumps of 15,000 m3/h, three pumps of 18,000 m3/h, and one pump each. There are a total of sub-combinations.

$$N_{Sub-combntion} = G \prod_{i=1}^{4} C_{m_i}^{u} = C_3^3 \times C_2^7 \times C_1^4 \times C_1^1 = 84 \quad (10)$$

As a result, the combination of the prior example yields 84 potential combinations.

In the end, we discovered 17314 combinations after scanning every possible combination, and we estimated the flow, power, and matching efficiency for each of these. Using the "Remove duplicate rows in Excel" tool, combinations are verified. The flow, power consumption, and efficiency of every potential combination are now stored in a database.

B. Calculation of Sea water Demand: The need for seawater changes depending on how many production lines or workshops each unit has running. In order to compute the entire demand, as indicated in Table II, it is sufficient to prepare an Excel table with the various manufacturing lines and their current operational status.

TABLE II. CALCULATION OF SEAWATER DEMAND

State of the plant		
Users	*Number of operating line*	*Demand (m^3/h)*
Power plant	5	17895
Production lines	7	76040
Total demand (m^3/h)		93935

To choose the combination that can pump the exact required flow while using the least amount of power and maximizing efficiency, it is necessary to set conditions on the flow, power consumption, and efficiency.

The first requirement on our calculation page is called "optimum flow"; it aims to find combinations with a flow rate greater than the demand with the least amount of overflow.

Condition 2 "minimum power absorbed": This second requirement aims to select Test 1 combinations that have the least amount of power absorbed.

criteria 3: "Maximum Efficiency": The third criteria require selecting the combination that has the highest level of efficiency out of those that passed conditions 1 and 2.

The "IF" function is used to do the tests, which determines whether the condition has been met and returns a value if the outcome of a previously defined condition is true or a different value if it is false.

RESULTSANDDISCUSSIONS

The Excel function "VLOOKUP" is used to find a value in the target column and return it to a specific cell in order to illustrate the ideal combination, its properties, flow, and absorbed power.

We evaluated the energy consumption of the station over the course of 15 days with the consumption that would have occurred over the same period (from May 25 to June 8 2017) in order to determine the gain attributable to the employment of this management system.

Figure 4 depicts the changes in demand, pumped flow, and flow to be pumped following improvement throughout this time period. We observe that the pumped flow is significantly greater than the demand, which accounts for the spillway overflow. The evolution of the flow after improvement exactly matches the demand, making it the ideal flow.

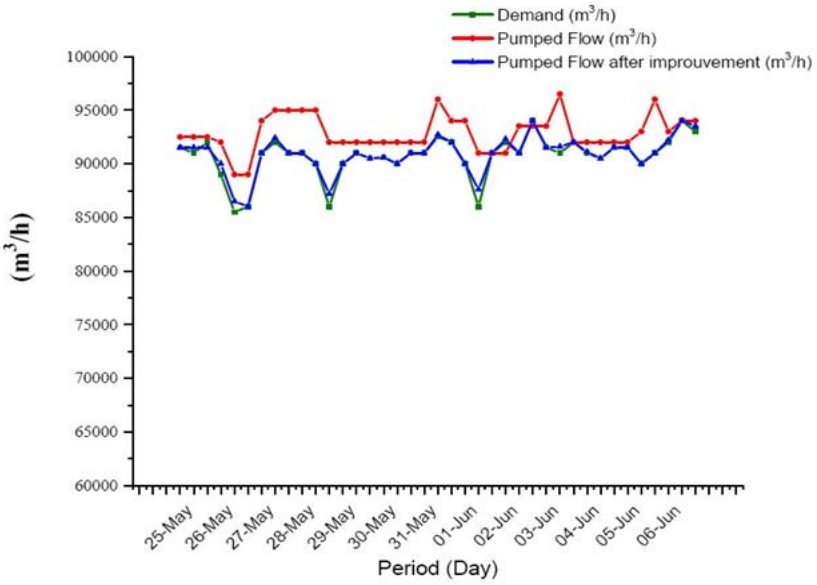


Fig.4.Evolution of demand, pumped flow and flow after improvement.

Figure 5 depicts the development of the actual absorbed power over the same time period as the improved power produced by our management style. The real power is definitely higher than the enhanced power, and we also see several spikes in the real power's evolution that can be attributed to the unjustified start-stop pumps.

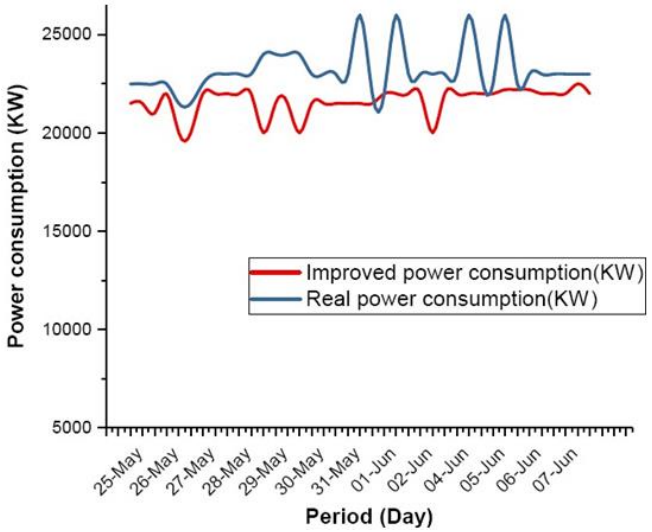


Fig.5. Variation in real and improved power consumption.

Finally, we determine the projected benefit by comparing the energy used in practise to the energy used in a trial period under our suggested management style. Table III presents the outcomes of the anticipated gain.

In the end, we determine the predicted benefit by comparing the energy used in practise to the energy used under our suggested management mode during the trial period. Table III displays the projected gain's outcomes.

TABLE III. EXCEPTED GAIN

	15 days	1 year
Old consumption MWh	7 911.13	189 867.20
New consumption MWh	7 254.40	174 105.79
Gain by MWh	656.72	15 761.41
Gain by DHs	459 707.77	11 032 986.48
Gain by %	8.3%	8.3%

CONCLUSION

The implementation of a management system for seawater pumping stations has been examined in this research. In order to meet such a demand for water, a strategy for selecting the best possible combination has been established, taking into account the need for maximum efficiency, minimal power usage, and optimal flow. We were able to determine the main issues with the pumping station thanks to a preliminary examination. The effectiveness of the systems and the management of consumption were then assessed through a thorough audit. Finally, we concluded our case study by demonstrating how the proposed energy optimization approach and improvement options enable us to reach an expected annual gain of 11MDH. Another benefit is that this kind of project doesn't require any investment. And investment and lengthens the lifespan of the production's essential machinery.

REFERENCES

[1] The Moroccan law enacting the "National Strategy for Energy Efficiency," Law No. 47-09, is available online at www.amee.ma.
[2] M. Christenson, H. Manz, and D. Gyalistras, "Climate warming impact on degree-days and building energy demand in Switzerland," Energy Convers Manag, vol. 47, no. 6, 2006, pp. 671-686.
[3] Andrew B. Kipnis, "Audit cultures: neoliberal governmentality, socialist legacy, or technologies of governing?," American Ethnologist, vol. 35, no. 2, 2008, pp. 275-289.
[4] M. Kaddar, M. El Mouden, and A. Hajjaji, "Evaluation of energy savings by using high efficiency motors in a thermal power station," International Journal of Green Energy, vol. 14, no. 10, May 2017, pp. 839–844.
[5] International Organisation for Standardisation, "ISO 50001:2011 Energy management systems -- Requirements with guidance for use," 2011.
[6] I. Dzene, I. Polokarpova, L. Zogla, and M. Rosa, "Application of ISO 50001 for Implementation of Sustainable Energy Action Plans," Energy Procedia 72, 2015, pp. 111–118.

[7] "Electrical Energy Audit in a Malaysian University—A Case Study," 2012 IEEE International Conference on Power and Energy, Kota Kinabalu Sabah, Malaysia, 2 – 5 December 2012, pp. 616–619; H. Singh, M. Seera, and I. Mohamad, M.A.
[8] N. Tanasic, G. Jankes, M. Stamenic, et al., "Potentials for reducing primary energy consumption through energy audit in the packaging paper factory," in Environmental Friendly Energies and Applications (EFEA), 2014 3rd International Symposium on, IEEE, 2014. pp. 1–5.
[9] Bertoldi and T. Serrenho, "Energy Audits and Energy Management Systems under the Energy Efficiency Directive: what is the current situation?" in the EEMODS'15 Conference proceedings, Helsinki, September 2015.
[10] S. Backlund and P. Tholander, "Impact after three years of the Swedish energy audit programmers," Energy, Volume 82, March 2015, pp. 54–60.
[11] Tobias Fleiter, Wolfgang Eichhammer, Edelgard Gruber, and Ernst Worrell. Energy Efficiency (2012): "The German energy audit programme for firms- a cost-effective way to improve energy efficiency?"
[12] The Fairmont Press, Inc., 2008, "Handbook of energy audits," by A. Thumann and W. J. Younger.
[13] "Monthly review of the electricity energy market," Energy Research Enterprise (EPE), Year VI, Number 64, Rio de Janeiro, 2013.
[14] Useful Balance of Energy/2005, Ministry of Mines and Energy, Secretary of Energy Planning and Development, Brasilia, DF, 2005.

CHAPTER-3.7

Smart Car Parking

Deepak Kumar[1], Sandeep Kumar[2]
Assistant Professor, JBIT Dehradun

ABSTRACT: *The rise in population is a major concern as the operation of coffers becomes delicate. With the increase in the need for smart metropolises. Smart metropolises are developed in such a way that the problems are answered using technologies like Internet of Things (IoT) technology. One similar problem is parking. Parking in busy thoroughfares is delicate and is a cause of lot of vexation to the people. The difficulty lies in the fact that people won't know the vacuity of parking places. The end of this paper helps to ease the parking issues faced by the people by the use of a smart parking system. The free parking niche is determined using Ultrasound detectors connected to an Adriano board and the data is uploaded to the database. The data from the pall can be brought and the parking niche vacuity can be attained in real time through a web point. The paper also provides the methodology for enforcing this work. The effective software bias have been linked and the farther advancements which are probable have been described compactly.*

Keywords- Ultrasound detector, Database, Arduino, Smart car parking, cloud

INTRODUCTION

At the point when IoT is increased with detectors and selectors, the invention turns into an circumstance of the further broad class of digital physical fabrics, which likewise incorporates advances. For Example, keen networks, virtual power plants, brilliant homes, canny transportation and shrewd civic communities. Among the difficulties that defy in everyday life one of utmost necessary test is parking the car wherever people go. As our need expands our setting out supplements still because of extreme proliferation in application of vehicles and proliferation in crowd this design defy the violent assignment of parking auto especially amid busiest hours of the day. Amid zenith hours the maturity of the saved parking zone gets full and this leaves the customer to checkup for their parking among other parking area which makes further movement and abandons them with no sign on availability of parking spot. To master this issue there's clearly a demand for composed parking in business condition. To outline similar parking there need to assess reservation of parking space with ideal parking spot which relies upon cost and time. still this design compose the time driven grouping strategy which takes care of the issue of parking exercising opening assignment fashion. The abecedarian alleviation of this adventure is to dwindle the movement clog that happens in and around the civic zones which is brought on by vehicles looking for parking. In the diurnal papers, numerous papers with respect to the stopping issue each over India like Delhi, Mumbai, Chennai, Bangalore and multitudinous metropolitan civic areas. Developing crowd has made multitudinous issues; stopping issue is one of the enormous issues in our everyday life. In a current study, judges have set up that for one time, auto cruising for stopping made what might as well be called 38 times trips far and wide, consuming177914.8 liters of energy and delivering 730 tons of CO2.

PARKING GARAGE PROBLEMS

Trouble in chancing Vacant Spaces, snappily chancing an empty space in a multilevel parking garage is worrisome if not unbelievable, particularly on ends of the week or open occasions. Discovering spaces amid ends of the week or open occasions can take over 10 twinkles for around 66 of guests. colosseums or shopping center are swarmed at zenith ages, and trouble in chancing empty openings at these spots is a noteworthy issue for guests. shy car parking space prompt exertion blockage and motorist disappointment.

WORKING

There are colorful styles for the development of car parking robotization, study of numerous papers shows that mortal involvement in car parking is more. This should be reduced vastly and that will be the main ideal of designing an automatic car parking allocation system. There's comparatively lower robotization in practice when it comes to car parking allocation in our country. One similar illustration is the automated car parking system at the Bangalore International Airport. The system uses a combination of detectors, cameras, and software to manage the parking of vehicles in amulti-level car demesne. The system is designed to optimize space application and reduce the time taken to situate and recoup buses. Another illustration is the automated car parking system at the World Trade Center in Mumbai. The system uses a combination of detectors and lifts to situate and recoup buses. The system is designed to reduce the space needed for parking and to ameliorate the effectiveness of the parking process. While these exemplifications show that automated car parking systems are being enforced in India, they're still fairly rare. Countries like Europe, the United States, and Japan have enforced advanced mechanisms in making automated car parking allocation systems. thus, we made this design using simple detectors and a micro controller. Since mortal hindrance is seen in allocating spaces, gratuitous locks of vehicles be, especially during peak hours. therefore, optimal results are attained at a low cost when introductory detectors are used rather of using conventional styles as seen in shopping promenades. In this system, we've fitted an Ultrasound detector at the entrance of the gate on both sides and it's placed in every car parking niche available collectively. In parking places two detectors are fixed underground, the distance between two detectors is small enough to descry all the hatchback cars in India. This will help place detectors effectively in the parking system. thus, no cars will be left undetected by the Ultrasound detector. Then we use Arduino as the microcontroller to transfer the information entered by the detectors to the servomotor, TV, LEDs, etc. LEDs, LCDs, and servomotor are connected to Arduino as affair bias. therefore it reacts grounded on the inputs attained from the detectors i.e. discovery of vehicles and allocation of place. This will be an optimal car parking allocation medium and it'll have a cost effective approach in designing. Servomotor was used for gates open and close operations, and TV is used to display the details of a parking niche available with is a content addition from the references. In some cases, RFIDs were used. The operation of RFID medium will give more accurate results with high effectiveness. But this medium cannot be applied far and wide since people visiting the spots cannot be prognosticated before their appearance. The

input information that we admit are veritably anonymous. There's no place for obscurity when RFID's are used. It's insolvable pragmatically to give RFID receiver markers to all buses to be situated. Originally, when the car enters through the gate, the Ultrasound detector in the gate detects the car and sends the signal to the microcontroller, which resends the signal to the servomotor after checking the number of places available for parking. The servomotor is turned 90 degrees up to open the gate when there's a place available to demesne. The Ultrasound detector at the other side of the gate is used to count the number of cars entering the parking area and it decrements the counts and displays them on an TV. The display shows the remaining number of empty car parking places and the total number of places enthralled formerly. LED suggestion is used to show specifically which niche is filled and which niche is empty. therefore, we aim to propose a car parking allocation system that represents a completely automated model with minimum mortal intervention and overcome the limitations of being systems.

BLOCK DIAGRAM

The block diagram figure 1 mentioned below explains the methodology of the proposed project. The inputs for the microcontroller are the signals from the Ultrasound sensors in the entrance and the parking slots. Similarly, the outputs are given to the servomotor, LCD, LEDs, etc. The inputs received from the sensors are processed in the microcontroller and an alternative output required as programmed is received in the output devices. The total setup is powered by a 5V given to the Arduino. It can be operated up to 12v since we have connected a servomotor to the microcontroller. The inputs from the Ultrasound sensor in the entrance are given into the microcontroller. The microcontroller operates the servomotor there by opening the gate with respect to the inputs from the IR sensors inside the slots. This reduces the count in the LCD display, indicating empty spaces by LED indications. Servomotor helps in operating the gate. It will be closed if all slots in the parking garages are occupied completely.

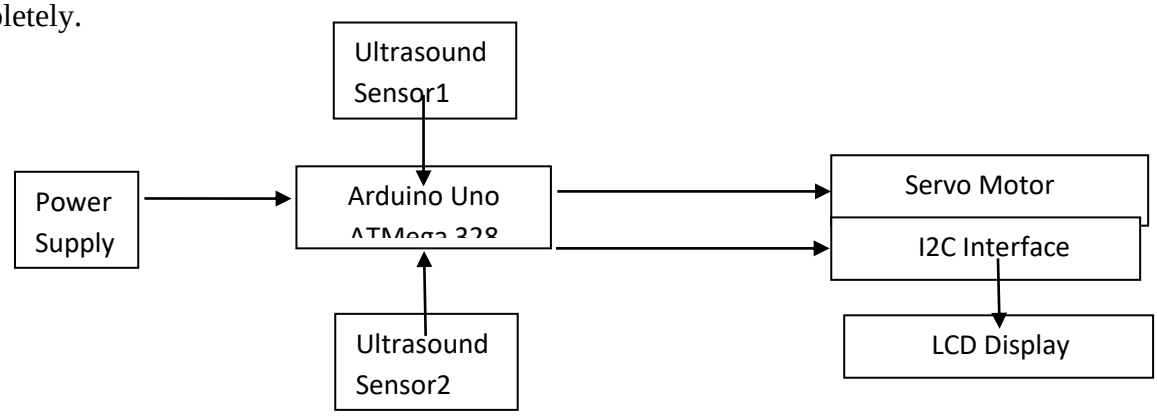


Fig.1 Block Diagram of arduino interface

The block diagram figure 2 corresponds to the hardware interaction with the web application. At first the ESP 8266 will Collect the data from the sensing unit i.e. the sensor and after that it will store the data in a database and then through web page and database interaction the data of several parking slots can be obtained with the help of website.

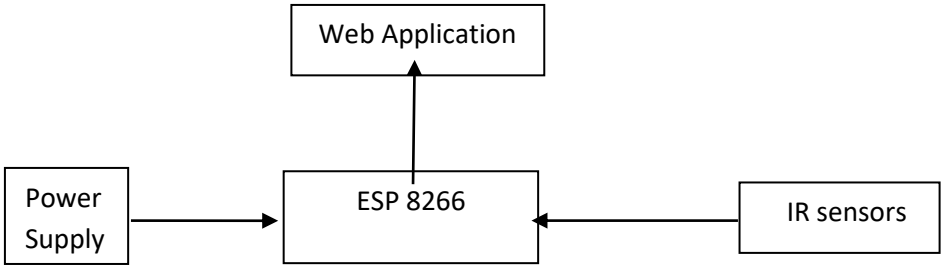


Fig.2 Block diagram of web Interface

The ESP 8266 can be powered using voltage between 4.5V to 10V. The ESP 8266 will also work with a maximum voltage between of 12V. But always it is highly recommended to keep the input voltage between 4.5V to 10V. Arduino Uno ATMega 328 Servo Motor LCD Display Ultrasound Sensor2 I2C Interface Power Supply Ultrasound Sensor1 ESP 8266 Power IR sensors Supply Web Application

APPLICATION

It can be in chancing empty parking places before entering inside the parking area. It can regulates the entry of redundant vehicles when all the places were enthralled. It's suitable for all kinds of structures. Requires low conservation. Detectors used are veritably simple and optimized grounded on our requirements. Simple system and cost of construction is low. Regulates business in front of the parking places. Proceedings of the International Conference on Artificial Intelligence and Smart Systems. Gives proper instructions through LCD displays. User friendly Conclusion This system gives solution to the problem of traffic congestion in front of the parking garage. Conventionally there is no such automated system for allocating spaces for parking vehicles. So, this will make parking allocation simple and well organized with systematic first come first serve basis. Directing people to empty parking slots and indicating exact locations adds more credibility to this system. In case of no space in that specific floor's parking garage, it will direct the driver to go to next floor for parking. These were some of the merits of the system. Though this will be useful, there is no assurance of its speed of regulation when more vehicles accumulate. It may regulate the traffic, but this system will not be very useful during leisure hours and this system cannot work ideally. The concept of pre booking of parking slots will be new but it will create some confusions. If the person who booked a parking slot arrived lately, the place should be spared to another individual. Future scope We can develop an Integrated smart parking system so that one can manage a parking slot easily with the help of web application.

Reference

[1] 2020 International Conference On Emerging Trends In Information Technology And Engineering (Ic-ETITE) 978-1-7281-4142-8/$31.00 ©2020 IEEE
[2] Second International Conference On Smart Systems And Inventive Technology (ICSSIT 2019) IEEE Explore Part Number: CFP19P17-ART; ISBN:978-1-7281-2119-2
[3] International Journal Of Computer Applications (0975 – 8887) Volume 169 – No.1, July 2017
[4] Noor N.M, Z Razak And Mohd Yamani, ―Car Parking System: A Review Of Smart Parking System And Its Technology, Information Technology Journal, 2009.
[5] Mohammed Ahamed, Wangguangwei "STUDY ON AUTOMATED CAR PARKING SYSTEM BASED

ON MICROCONTROLLER". International Journal Of Engineering Research And Technology ISSN: 2278-0181, Volume-3, Issue-1, January-2014

[6] Wuhongwang "METROPOLIS PARKING PROBLEMS AND MANAGEMENT PLANNING SOLUTIONS FOR TRAFFIC OPERATION EFFECTIVENESS" Hindawi Research Paper, Volume 2012, Article ID-678952

[7] Ma. Janice J. Gumasing And Charles Aaron V. Atienza "Parking System For Shopping Centers In Metro Manila" IEEE Journals

[8] Sungheetha, A Key, And Rajesh Sharma. "Cost Effective Energy Saving System In Parking Spots." Journal Of Electronics 2, No. 01 (2020): 18-29.

[9] International Journal Of Computer Applications (0975 – 8887) Volume 169 – No.1, July 2017

[10] 2018 5th International Conference On Industrial Engineering And Applications

[11] Proceedings Of The International Conference On Artificial Intelligence And Smart Systems (ICAIS-2021) IEEE Explore Part Number: CFP21OAB-ART; ISBN: 978-1-7281-9537-7

[12] 2017 International Conference On Advanced Computing And Communication Systems (ICACCS -2017), Jan. 06 – 07, 2017, Coimbatore, INDIA

CHAPTER-3.8

Optimal Bidding in Restructure Power System

Deepak Singh Karki[1], Deepak Kr. Verma[2]
[1]Lecturer (EE) JBIT Dehradun, India
[2]Asst. Professor, JBIT Dehradun, India
deepak.karki00@gmail.com

ABSTRACT: *This paper dealt with brief knowledge of optimal bidding in restructured power system. Participants in a competitive electricity market develop bidding strategies in order to maximize their own profits. On the other hand, it is necessary for regulators to investigate strategic bidding behavior in order to identify possible market power abuse and to limit such abuse by introducing appropriate market management rules.*

Keywords-- Optimal Bidding, Electricity market, Energy Auction

INTRODUCTION

Since the 1980's much effort has been made to restructure the traditional monopoly power industry with the objectives of introducing fair competition and improving economic efficiency. The creation of mechanisms for power suppliers, and sometimes for large consumers, to openly trade electricity is at the core of this change. Ideally, the market structure and management mechanisms or rules in an electricity market are sufficiently well designed and competition among participants sufficiently vigorous to direct the operation of the market towards maximizing social welfare.

OPTIMAL BIDDING

For a GENCO to survive in competitive environment, it has to operate very efficiently. But only efficient operation sometimes may not suffice because in the energy auction it has to sell its products at competitive prices to get the maximum profit out of it. Several factor affect the profitability of GENCO like own bids, bids placed by its competitor, total energy demands among others etc.

While a GENCO has no control over the bids of its competitors and the energy demand, it can make its own strategy to place such a bid that provides it highest profit at lower risk. By risk it is meant that the amount of regret involved. A bid is called highly risky if it can yield large profit but its probability of being selected is low, so more often than not it will not be selected leading to regret. A low risk bid is such bid, which may have lower profit earning capability but high probability of being selected, so there is no regret.

The Method by which the optimal bidding problem is solved are as follow:

Game theory

Dynamic Programming

A genetic algorithm-based method.

Optimization based bidding strategies.

Markov Decision Process

ENERGY AUCTION AND COMPETITIVE BIDDING

In a competitive electricity market, the seller and buyers submit bids for energy buy and sell. The bids are generally in the form of price and quantity quotation and specify how much the seller or buyers are willing to buy or sell and at what price.

After the bids are available to the market operator, it settles the market based on some criteria. Once the market is cleared, all selling participants receive a uniform price for their power delivered, i.e., the market price from the buying.

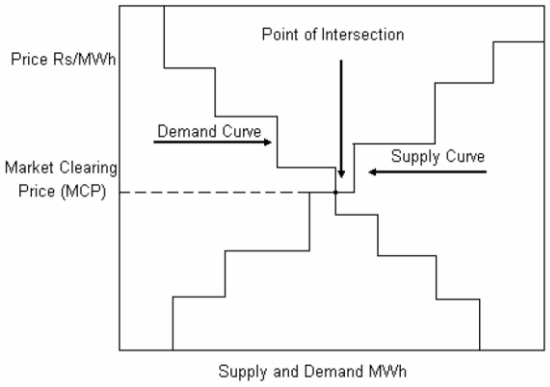


Fig. 1

In case of auction, where all winning bidders are offered the same price without discrimination, and regardless of their individual bid, is known as non-discriminated or second price auction. This is usually the price of the highest priced bid that is cleared in the market.

The non-discriminated auction provides incentives to bidders to bid on their true costs and avoid guessing the bids of other. On the other hand, in a discriminated auction or first price auction, all bidders are not offered the same price after the market is settled. The bidders get the price that they had bid for, in the first place. A disadvantage of this system is that it can give gaming opportunities for the participants thereby providing ample scope for over-bidding and pushing up the market clearing price.

Once the buyer and seller bid the amount of energy and the price, the power exchange forms an aggregate supply bid curve for consumers. The curve for suppliers and aggregate demand bid curve for consumers. The curves are plotted on coordinates of, supply and demand energy and price as shown in the figure (1). The point of intersection of two curves determines the market-clearing price (MCP). At this point, the supply satisfies the demand. The point of intersection of two curves determines the market clearing price. determines the market-clearing price (MCP). At this point, the supply satisfies the demand. The MCP is the price of electric energy that is paid by consumers at all the places. The sellers are also paid the price equal to the MCP.

Consider the power exchange auction. MCP is the highest sell bid or lowest buy bid accepted in the auction. Thus, a seller is certain he will be paid no less than its cost of production if he bids its marginal cost, and may be paid more. If a seller bids less than his marginal cost, he will lose money because his bid may set the MCP. If he bids more than his marginal cost, he may bid more than other sellers and fail to be selected in the auction. If the MCP is higher than this marginal cost, then he would earn profit or contribution to fixed cost. Buyer itself makes similar considerations.

AUCTION AND BIDDING PROTOCOLS

An auction is an economically efficient mechanism to allocate demand to suppliers, and the formation of electricity markets. Bidding is an issue connected to the auction. It is obvious that development of bidding strategies should be based on market model and activity rules, especially auction rules and bidding protocols. Many auction methods exist and can be classified in many ways. The two main categories differ according to whether the auction is static or dynamic. In static auctions, the bidders submit sealed bids, while in dynamic auctions bidders can observe the bids of others and revise their own sequentially.

Static auctions can be classified according to discriminating or non-discriminating pricing. In the former bidders are paid their offered prices if they win. In non-discriminating auctions, all winning bidders are paid a uniform price, such as the first losing bid or the last winning bid. In cases of multiple sellers or multiple buyers, the non-discriminating pricing auction is usually employed to encourage the bidders to bid their marginal costs or benefits. Auctions can also be classified as “open” or “sealed-bid”. Open auctions may be classified as English (ascending bid) or Dutch (descending bid).

Sealed-bid auctions can be classified into ‘first price’ and ‘second price’ auctions, and both of them are usually referred to as non-discriminating auctions, the only difference is whether the uniform price is set according to the last winning bid or the first losing bid. An auction is called a double one when both the sellers and buyers are required to submit bids. To our knowledge, almost all operating electricity markets worldwide employ the sealed bid auction with uniform market price.

Another important factor related to bidding strategies is bidding protocols. Depending on different market designs, the energy bids may include several price components (multi part bid) or a single price component (single-part bid). In either case, the energy bid may include several energy price segments depending on the amount of energy supply.

CONCLUSION

The electricity market is the same as other markets (e.g. vegetable market) but with some exceptions. These exceptions are due to high risk in the electricity market. The electricity market is very risky because electricity is not storable in bulk quantity. The cost of continuity of electricity is more than the cost of electricity in the electricity market. In a fully competitive electricity market, each participant should bid at its marginal cost in order to maximize its revenue. However, some practical electricity markets such as India electricity

market are not a perfectly competitive one because of the characteristics such as the severe generation and transmission constraints. So, it is critical for a GENCO to devise a good bidding strategy in order to maximize its potential profits.

REFERENCES

[1] A.K. David, and F. Wen, "Strategic bidding in competitive electricity market: A literature survey," in Proc. IEEE Power Eng. Soc. Power Eng. Conf., 2000, pp. 2168-2173.
[2] M. Shahidehpour and M. Alomoush, Restructured Electric Power Systems. New York: Marcel Dekker, 2001 H. M. Merrill, "Regional transmission organizations: FERC Order 2000", IEEE Power Engineering Review, July 2000, pp.3-5.
[3] The European Commission, Opening up to choose: The single electricity market, 1999. 7. R. D. Tabors, "Lessons from the UK and Norway", IEEE Spectrum, Aug. '96, pp.45-49.
[4] Svenska Kraftnlit, "The Swedish electricity market reform and its implications for Svenska Kraflnlit", Second Edition, 1997.
[5] National Electricity Market Management Company (Australia), "An introduction to Australia's National Electricity Market", 1998.
[6] W. Mielczarski, G. Michalik and M. Widjaja, "Bidding strategies in electricity markets", Proceedings of Power Industry Computer Applications Conference, 1999.
[7] T. Alvey, D. Goodwin, X. Ma, D. Streiffert and D. Sun, "A security constrained bid clearing system for the New Zealand wholesale electricity market", IEEE Transactions on Power Systems, May '98,pp.340-346.
[8] J. Parikh, K. Bhattacharya, S. Reddy and K. Parikh, Chapter 5- Energy System: Need for New mentum, India Development Report: 1997, Oxford University Press, 1997.
[9] A.K. David, "Risk modelling in energy contracts between host utilities and BOT plant investors", IEEE Transactions on Energy Conversion, June 1996, pp.359-366.
[10] H. Rudnick, "Pioneering electricity reform in South America", IEEE Spectrum, Aug. '96.

CHAPTER-3.9

Electrical Network: Resilience Assessment

Rajesh Chamoli[1], Deepak Kr. Verma[2]
[1]Lecturer (EE), JBIT Dehradun, India
[2]Asst. Professor, JBIT Dehradun, India
rc18ee39@thdcihet.ac.in

ABSTRACT: *The development of electric power is a crucial component of economic growth and a crucial assurance of industrial modernization. Today, as people's quality of life has improved, electricity has grown to be essential to maintaining people's safety. Therefore, economic growth, industrial modernization, and people's lives are significantly impacted by the steady and dependable development of the electricity system. The power system and its combination have developed into a significant application area known as the reliability evaluation of the power system. This field has permeated the entire industrial chain of the power system and is a reliable assurance that the industrial chain will reap economic and social benefits. This study proposes the primary steps to increase the operation reliability of the power system in order to satisfy the operational requirements based on an examination of the operation reliability of the power system.*

INTRODUCTION

The performance of large-scale equipment is crucially dependent on system reliability, which is not only related to the dependability of each component but also to the way those components are connected. The social economy of China is expanding quickly, and it is progressively going in the direction of a high-level, high-capacity Internet. Problems can emerge as the process continues to evolve. The security and dependability of the electrical grid are the most visible. A large-scale power outage event frequently results in power outages in several locations, which ultimately affects people's everyday activities and quality of life. In order to increase the cognitive level of power system operation reliability, it is important to emphasise the stability and security of power grid operation. This directly increases the reliability of power grid operation to the level of national security strategy and allows for the realisation of in-depth studies of power grid operation.

Explanation of the Dependability of Power System Functioning: The notion of reliability applied to power system operation is primarily intended to describe the dependability of power system operation. At first, people would interpret reliability as a symbol to gauge the quality of items. The provision of reliable electric energy is the most fundamental duty of the power system. The protection of some of the equipment management in the process of the power system must be realized for the operation of the power system to be reliable. Operation before. Here, dependability refers to a system's capacity to do its most fundamental tasks within the confines of a particular time frame and set of conditions.

Definition: Applied science, power system reliability combines theory (reliability principles and methods) with practice (real-world power system engineering challenges). It has two components: power industry reliability management and power system reliability engineering technology.

Essence

In order to fully utilize the potential of the power supply system and continuously deliver stable power energy to all users, as well as to achieve the goal of total quality management and comprehensive safety management for the entire power system, it is essential to use economical and reasonable technical means and management techniques. In general, activities to increase the level of power system reliability fall under the purview of the power industry's reliability work, including extending the service life of the system, enhancing the system's safe operating environment, and other such actions.

Primary Tasks

The primary goal of power system operation reliability is to collect data generated by power components throughout historical operation processes as well as data collected following component reliability tests. The dependability of components can be resolved by analyzing this section of data. The necessary analysis and simulation processing may be carried out while taking into account the power model's predicted load changes and the power system's dependability model. The planned function in the power system cannot be completed by this type of simulation in the allotted time. In order to obtain the most useful data and conduct a focused analysis, we must additionally do the relevant computation after the simulation. The operation and control of the power system may then be thoroughly evaluated, and auxiliary decision-making can be done, on the basis of opportunity system investment and reliability coordination. Finding the solution to reduce dependability and setting up the necessary departments to implement it are the goals.

Reliability Analysis

i) Purpose of testing: The whole system reliability quantitative system should be used in power system planning and design to detect and analyse potential system faults, and corresponding technical measures should be taken to reduce the impact of faults on the normal operation of the system. This is in accordance with the experience of power system reliability detection. The thorough evaluation of dependability is ensured, and the comprehensive advantages of power system operation are kept in the best state for a long time, when compared to the cost investment and the economic benefits produced by system operation. For the evaluation of power system reliability, we determine the purpose of detection, then we can develop the corresponding detection technology, so as to determine the type of fault, and effectively make professional evaluation and judgment on the severity of the fault. In order to make the reliability of power system reach our expected level, ensuring the adequacy and security of power system is the primary evaluation property. In the event of a sudden malfunction, the necessary precautions are taken to prevent the impact of a drop in power load on system components. The integrity of the system should also be taken into consideration in order to separate and regulate the system's primary components.

ii) Stage of planning and design: When designing a power system, it is important to consider ways to reduce harm in the event that the needs are exceeded. To prevent the effects

and extend the blackout range, the system needs to be able to resist various levels of disruption. At the same time, it safeguards the equipment from harm while providing a safe working environment for the personnel. The power system's operation dependability evaluation carries out numerous operating modes while reducing the risk that is under our control. The design and determination of the system's reserve capacity and maintenance plan, as well as the output and input power data values and output and input electric energy of linked systems.

iii) Reliability standards: The numerical parameters that satisfy the stated reliability evaluation goal, or the online unreliability criteria. First and foremost, the transmission and transmission linked system must be able to successfully handle the conditions of a power generation system and a rapid system outage in order to define the performance test requirements. The system's functioning before the disturbance and the disturbance itself should be included in the combination of distinct defects. The system should be kept in continuous power supply mode to account for the loss of one component in a multi-component system. As a result, the N-1 concept is used in numerous nations' transmission and transmission interconnection networks. This criterion has some dependability and stability, and its idea is indirect and unambiguous in order to prevent the reduction in power consumption caused by unexpected failure. It is frequently employed in the assessment and evaluation of power system dependability.

iv) Simple implication: The power source can operate continuously throughout the day as long as it meets the quality and quantity specifications outlined by the power system. We can thoroughly assess if the power generation is enough and whether the system is flawed through the power generating system. When a failure arises, the power generating system will communicate that there is not enough power, and the load point will not be able to receive the electricity that the transmission and distribution system is transmitting. In contrast, electricity will be sent to any load point without interruption. The most important element in regular electricity generation is the system's dependability.

v) Technical evaluation: The dependability information management system must be established as the next step. The observation record is created in accordance with the system's operational status at the location, and when data processing is completed with the aid of computers, it serves as the foundation for dependability evaluation. In order to judge the behavior of system components, examine the nature of disturbance causes, and enhance reliability modelling, it is necessary to establish a detection device for major accidents, install disturbance detection equipment in the system operation status, and detect disturbance information and fault judgement of the gearbox and gearbox interconnected system.

Measures to ensure the electrical system operates safely: In order to increase the overall degree of dependability, the study of power system reliability primarily takes into account data collecting, logical analysis, and key fulcrum search, as illustrated in Figure 1.Wecan do the ensuing analysis after screening reasonably if we have a solid understanding of the contents of Figure 1.

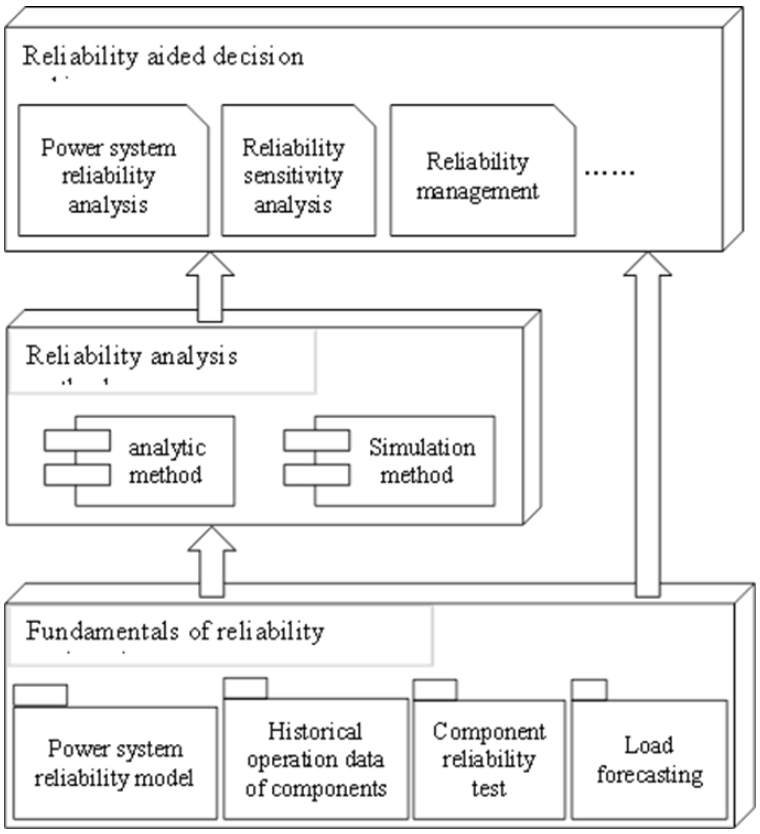


Figure 1. Main work of power system engineering reliability

Safeguarding the system during operation:

i) Operation of relay protection system: Power systems themselves are a part of the network that connects them. When a connection experiences operational issues, the entire system is affected and may possibly fall apart as a result. The relay protection system is the most crucial connection among them. In order to determine whether the relay protection system is reliable, it is important to first determine whether it has refused to act when the power supply fails, and then to determine whether it has taken the incorrect action. The relay protection system device itself has some automation and a defence function that can fulfil the requirements of the power system's stable functioning.In order to operate the power system, it is required to identify any impediments by using relay protection, which can then be targeted to address the issue and prevent additional damage to the power system. How therefore can the dependability of relay protection system construction be improved? It must be done from the following angles through reasonable analysis:

Relay protection system dependability requires thorough oversight, which might range from the creation of the relay protection device through the supervision and usage chain.

(1) Create a system that is very reliable, strengthen the pertinent rules and regulations, and constantly train workers so that the appropriate fixes may be applied in the event of unforeseen issues. The criteria of a relay protection system's dependability may be addressed through a solid technological basis, and the system's overall operating reliability can eventually be achieved.

(2) The relay protection system can also be altered if the functioning of the power system is unable to comprehend the situation. This is mostly due to the relay protection system's negative environmental effect, which prevents it from performing as intended. One of the most important considerations is the sealing of the relay protection itself, and an appropriate modification should be made for indoor use.

ii) DC power supply of power system:

(1) Perform well in the areas of design, choice, and procurement. In contrast, a typical power supply finds it challenging to satisfy all requirements, making it unable to ensure dependability. As a result, most individuals will employ high frequency switching power supplies. In addition to being able to fulfil weight criteria, this power source provides high power and low emission. It can ensure that the capacity to withstand electromagnetic interference is met together with the dependability criteria.

(2) Reasonable battery management and selection. With its unique benefits, sealed lead-acid batteries may be used to satisfy the needs of a reliable power system. Due to the sealed nature of the valve-regulated sealed lead-acid battery, there won't be any leaks or acid mist. Furthermore, it has a high degree of sealing and may shield and isolate the positive and negative plates.

By doing this, the material won't come off as readily and its service life can be substantially increased. After choosing a battery, it is vital to maintain and repair it in order to identify any battery shortages and fulfil dependability standards.

iii) Human error as a contributing component: The electricity grid may collapse due to technical operators' errors, which is brought on by human causes. As a result, it is examined if human factors are reliable: When there is a problem with the electricity grid, it is important to quickly pinpoint the source of the problem and then come up with workable solutions. Human activity will have a direct impact on how well the system recovers from failure. For instance, it is important to thoroughly inspect the real position of the three-phase circuit breaker and manually fix the defect when the signal of "three-phase position inconsistency" is present in the single-phase operating circuit breaker. There will be positive sequence, zero sequence, and negative sequence voltage and current during non-full phase operation.

CONCLUSION

People utilize more electrical devices in their daily lives as China's economy continues to grow. The dependability of the electricity system, which is the primary engine for the nation's development, has a direct impact on the growth of the social economy and the general standard of living. This advances stricter standards for the dependability of the electricity grid. The national power supply must be ensured in order for the power system to function. Although the needs of the power system can be met with the use of cutting-edge machinery and safety controls, nothing is infallible. Once the electricity system fails, it will have an impact on people's lives and productivity, as well as the growth of the country's economy.

Therefore, the reliability of power system is not the demand of the power industry itself, but also the core guarantee for the orderly development of people's life and production.

REFERENCES

[1] R. Viral, D.K. Khatod. Optimal. Planning of Distributed Generation Systems In Distribution System: A Review [J]. Renewable And Sustainable Energy Reviews, 2012, 16 (7): 5146- 5165.
[2] Jiang W, Wei B Y, Xie Ch H, et al. An evidential sensor fusion method in fault diagnosis [J]. Advances in Mechanical Engineering, 2016, 8 (3): 1-7.
[3] Shah D G, Crow M L. Online Volt-Var control for distribution systems with solid state transformers [J]. IEEE Transactions on Power Delivery, 2016, 31 (1): 343-350.
[4] Feihu Yang. Research on operation reliability management of power system [J]. Neijiang science and technology, 2017 (10): 130-131.
[5] Fei Zhong. Research on operation reliability of power system [J]. Communication world, 2017 (17): 164-165
[6] Billinton, R., & Allan, R. N. (1996). Reliability Evaluation of Power Systems (2nd ed.). Springer.
[7] Ajjarapu, V., & Christy, C. (1992). The continuation power flow: A tool for steady state voltage stability analysis. IEEE Transactions on Power Systems, 7(1), 416-423.
[8] Galiana, F. D., & Carreras, B. A. (1993). Practical applications of sensitivity analysis to power system security assessment. IEEE Transactions on Power Systems, 8(3), 1090-1097.
[9] Hines, P., Apt, J., & Talukdar, S. (2008). Large blackouts in North America: Historical trends and policy implications. Energy Policy, 36(11), 4022-4030.
[10] Sharma, M., & Kumar, A. (2014). A review of power system reliability assessment techniques. Renewable and Sustainable Energy Reviews, 34, 415-426.
[11] Chowdhury, A., & Rahman, S. (2010). Power system reliability analysis incorporating distributed generation. IET Generation, Transmission & Distribution, 4(8), 960-971.
[12] Guo, H., Liu, D., & Huang, H. (2012). Power system reliability assessment considering wind power penetration. Electric Power Systems Research, 84, 110-118.
[13] Li, Y., Liu, H., & Chen, C. (2014). Risk assessment and reliability evaluation for power systems with wind power integration using Monte Carlo method. IEEE Transactions on Sustainable Energy, 5(4), 1308-1316.
[14] Wan, C., & Agalgaonkar, A. P. (2016). Power system reliability assessment with renewable energy sources: A review. Electric Power Systems Research, 131, 17-27.
[15] Zhang, P., Li, Z., Wang, X., & Zhang, N. (2017). Power system reliability analysis with energy storage system: A review. Renewable and Sustainable Energy Reviews, 69, 33-43.

CHAPTER-3.10

Review on Electric Vehicles

Rajesh Chamoli[1], Deepak Kr. Verma[2]
[1]Lecturer (EE) JBIT Dehradun, India
[2]Asst. Professor, JBIT Dehradun, India

ABSTRACT: *The desire to convert from traditional, pollution-producing cars that operate on fossil fuels to pollution-free electric cars that use electricity generated from renewable resources is gradually growing. This review intends to present the evolution of electric hybrids, their sources of supply, pros and disadvantages, categorization, and main ingredients through the analysis of journals, blogs, and statistical data. The main problems with electric cars are examined, and recommendations are made. Additionally included are the characteristics of torque development, CO2 emissions, and variables influencing the adoption of electric cars. Included are research on load performance, range characteristics, heat management, anti-jerking systems, wireless charging, and several other aspects of cars.The growing popularity of e-vehicles, their sales, and significant uptick in their numbers, as well as government initiatives to encourage their use, are also brought to light. Also discussed are India's ambitious 2030 e-vehicle strategy and the initiatives made to promote electromobility. According to the journal's summary, proposals for electromobility and renewable energy-based green power production would eventually result in a world without pollution.*

Keywords: Green Electricity & Electromobility, Government Policies, Demand, Electric Vehicles, Drawbacks

INTRODUCTION

The most popular and frequently utilised fuels worldwide are fossil fuels. And in the incredibly little time since then—just over 200 years—humans have devoured an enormous quantity of them, almost eradicating fossil fuels and substantially affecting the climate. The world's consumption of fossil fuels is not at a standstill, and the fuel supplies are limited. As a result, fossil fuels will exhaust sooner. Oil is consumed on a global scale at a rate of more than 11 billion tonnes annually. 4 billion tonnes of crude oil reserves are being lost every year.ly important is. The era of fossil fuel engines is gradually coming to an end, and the development of novel technologies has begun to revolutionise the world.Our known oil resources will last until 2052 if this trend continues, without any adjustments for our expanding population or aspirations[1]. People should convert to green energy and shun energy providers that don't provide it. The single most important thing we can do to combat climate change is to switch to green energy. All renewable energy sources, including the wind, sun, tides, earth, and so on, may be used to generate green energy. The reliability of future industrial sector expansion, transportation, and life depend on efficient power production and use. Considering the high levels of pollution and environmental harm, the purposeful introduction of new, risk-free energy sources

HYBRID VS. ELECTRIC VEHICLES

If a car uses more than one type of onboard energy to propel itself, it is considered a hybrid. In addition to one or more electric motors and a battery pack, a hybrid will also feature a conventional internal combustion engine and a gasoline tank. Diesel engines and hybrid systems also come at an additional expense. So far, it has proven to be too expensive to install both in the same car. When the vehicle is slowing down or coasting downhill, the motor and generator together produce power to replenish the battery while absorbing some of the motion. All the extra momentum in a typical automobile is lost as heat in the brakes. Conventional hydraulic brakes are still required to stop a car rapidly because regenerative braking is insufficient.If the hybrid system has adequate electrical capacity, the car might be driven solely on electricity.

At the end of 2010, plug-in hybrids first started to arrive on the market. It offers a mechanism to connect the battery to an electrical outlet for charging while the vehicle is stationary. The advantage of the plug-in hybrid is that most short excursions can be made in all-electric mode, saving the petrol engine for longer drives.

Classification of Hybrid and Electric Drive Vehicles:

- Micro-hybrid gasoline/diesel powered engines, where just the start-stop operations of electric components are utilised.
- Mild hybrid engines, which employ regenerative braking to assist the combustion engines.
- Full hybrid engines, in which the combustion process is supported by an electric motor. One might operate a vehicle only on electricity.
- The term "zero-emission vehicles" is also used to describe automobiles without emissions, which do not emit any exhaust gases into the atmosphere while being driven.
- Battery electric vehicles" (BEV) are vehicles fueled by batteries and propelled only by an electric motor. An externally charged high-voltage battery supplies the energy needed to power the vehicle.
- High voltage batteries in plug-in hybrids may be charged outside.
- Combustion engines in hybrids with range extenders generate electrical energy to run the motor

The Essential Elements of an Electric Car: The high-voltage battery with control unit for battery regulation and charger is part of the electric vehicle driving system.

- Electric motor/generator with cooling system and electronic control.
- The differential and the gearbox.
- Brake mechanism.

- High-voltage air conditioning for regulating the temperature inside vehicles.

The following is a list of the different parts, as generator/electric motor, differential-equipped gearbox, energised electronics, High-voltage Batteries, Lines, and Systems electronics box with battery regulation controller, cooling method, brake mechanisms, compressors for high-voltage air conditioners, high-voltage heaters, Chargers for batteries, sources for external charging, and charging contacts.

Fuel Cell Automobiles: Fuel cell cars (FCVs) have the potential to drastically lessen our reliance on imported oil and cut back on the damaging pollutants that cause climate change. FCVs don't have any hazardous exhaust emissions because they run on hydrogen gas rather than petrol. The components of a fuel cell are as follows. The electricity is controlled by the power control unit.

Compared to an internal combustion engine, the electric motor pushes the car more silently, smoothly, and effectively while also requiring less maintenance. In order to power the electric motor, hydrogen gas and oxygen are converted into electricity in the fuel cell stack. Regenerative braking energy is captured and supplemented by the High-Output Battery, which also powers the electric motor.To extend driving range, hydrogen gas is compressed at an incredibly high pressure and stored in the hydrogen storage tank. FCVs have a traditional appearance yet employ cutting-edge technology. The Fuel Cell Stack is the engine of the FCV. The stack turns oxygen from the air and hydrogen gas stored onboard into electricity, which drives the vehicle's electric motor.

Solar Automobiles: Solar-powered vehicles use electricity to capture solar energy. The battery that powers the car's motor is fuelled by this electricity. Some solar vehicles send the energy straight to the electric motor without utilising a battery. The University of Michigan Car, the MIT Solar Car, and the Berkley Solar Car are excellent examples of the newest solar-powered vehicles. Solar panels use photovoltaic cells as its primary means of converting solar energy into electrical current. They include semiconductors, often silicon, which absorb light. Electrons in semiconductors are liberated by the sun's energy, causing an electron flow. In solar automobiles, that flow produces the electricity needed to run the battery and specialised motor.They don't add to the already excessive noise pollution on the roads since their solar panels operate quietly. Unlike petrol engines, which produce greenhouse gases, solar panels don't. Most crucially, solar energy is cost-free, broadly accessible, and completely independent of foreign oil for the solar vehicle driver. Technology from the aerospace, bicycling, alternative energy, and automotive sectors is combined in solar automobiles.

The benefits of electric vehicles: In comparison to petrol engines, the cost of fuel is almost completely reduced, and current developments make it easier to charge electric cars. DC fast charging is currently the fastest way to charge electric automobiles. In order to drive carbon-free, EV owners may also combine solar panels and home charging stations. However, it's become simpler than ever to charge an EV at a public station even without a charging station

at home. The engines of gasoline- and diesel-powered cars are among the major contributors of noise pollution, which is harmful to human health. On the other side, electric cars are practically silent. That's because compared to conventional automobiles, electric vehicles have better power-to-weight ratios.Additionally, electric motors offer more readily available power and steady torque throughout time. A battery-powered vehicle is almost never going to blow up when it hits something, and since massive battery packs greatly reduce an electric vehicle's centre of gravity, the vehicle is less likely to flip over. Less maintenance is required for electric cars, which also results in cheaper maintenance expenses.

Torque Comparison: As soon as the electric drive motor completes one circle, it will have reached its maximum torque. A start-up phase is not necessary for it to attain idle speed. The available torque decreases as the revolutions rise once a certain rpm level is achieved.

This motor rotates at about 14,000 rpm. Because of these features, an electric drive motor does not need a sophisticated gearbox. Internal combustion engines need to be running at idle speed in order to create torque. With increasing engine speed, the available torque rises. Furthermore, this feature of the internal combustion engine necessitates a gearbox with a variety of gear ratios. Clutch or a torque converter is used to transfer the torque to the gearbox.

Emissions of CO_2: Before 2050, the amount of global warming should not rise over 3.6° F (2°C) above the pre-industrial average. The only way to accomplish this aim is to lower CO2 emissions. By 2050, it is intended to reduce CO_2 emissions per person from the present level of 45 tonnes year to 0.7 tonnes annually. CO_2 emissions from electric vehicles are not produced directly. The evaluation of CO_2 producers, however, takes into account not only the vehicle but also the emissions that arise during the creation of electrical energy (for instance, in coal power plants).

Particularly in Germany, using "clean electricity" (i.e., electricity derived from renewable sources) and electromobility are strongly related. Comparing modern electric automobiles to those powered by internal combustion engines, it is reasonable to conclude that the latter emit fewer CO2 emissions per vehicle.

MAJOR ELECTRIC VEHICLE DRAWBACKS

The major drawbacks of owning an electric vehicle centre on range anxiety. When the car stops and there isn't a charging station nearby, that is the disadvantage. The deployment of electric vehicles should emphasise not only their universal acceptance but also the mandatory construction of charging facilities. The fact that many drivers will need to build a charging station at home is another significant drawback. The average battery life is predicted to be ten years, and new battery packs can be pricey. Finally, owning an EV doesn't completely eliminate gasoline expenditures. Capital expenses are needed for power generation as well. All other automotive accessories, such as the radio and car air conditioners, consume battery-powered electricity.

FACTORS AFFECTING THE DEPLOYMENT OF ELECTRIC VEHICLES

Technological elements (performance of the vehicle): While using electricity as a fuel for a vehicle has numerous advantages, it also has two drawbacks: it is more expensive, heavier to store, and takes longer to refuel. The existing electric cars would have a shorter driving range than diesel vehicles due to the former, and they would be more difficult to refill while driving due to the latter (Pearre et al., Citation2011). We now arrive at the key technical components. These include concern over driving range, recharge times, and the diversity of EV models.

Range Anxiety: According to research, range anxiety is a major deterrent to purchasing an electric vehicle (Jensen et al., Citation 2013). According to research, customers desire an optimal driving range of between 300 and 450 km (Zhu, Citation 2016). However, this is occasionally not really attainable, which leads to range anxiety. This is most frequently seen when a driver loses battery power when operating a vehicle for a prolonged period of time and is unable to forecast the approximate distance that may be travelled on a single charge. Drivers were reluctant to utilise EVs for lengthy trips because to the restricted and unreliable vehicle range (Noel et al., Citation2020). The dependability of these cars would suffer as a result.

Recharging time: In this case, the driver's choice of battery range would determine how long it would take to recharge the battery. Range would increase the more the battery is charged (Daziano& Chiew, Citation2012). However, because of the sluggish refuelling capacity, this results in excessive charging time (Egbue& Long, Citation 2012). Despite being considered the least troublesome element, it nonetheless raises the likelihood that an EV purchase would be rejected (Carley et al., Citation2013). When compared to fuelling an ICE car, most drivers find it more difficult to charge an electric vehicle (EV) (Brückmann et al., Citation2021).The inability to rapidly refuel and leave the house while driving creates discomfort, especially for on-road drivers, and they fear that EV charging time may pose to be a constraint in their daily routines (Graham-Rowe et al., Citation2012). Additionally, if a charging station is present at home, the driver cannot make unforeseen, hurried travels while the EV is being charged. It lessens flexibility.

The inability to rapidly refuel and leave the house while driving creates discomfort, especially for on-road drivers, and they fear that EV charging time may pose to be a constraint in their daily routines (Graham-Rowe et al., Citation2012). Additionally, if a charging station is present at home, the driver cannot make unforeseen, hurried travels while the EV is being charged. It lessens flexibility.

Economical aspects: These include the cost of buying the EV, the cost of gasoline, and the cost of the battery. According to several customer survey surveys (Carley et al., Citation2013; She et al., Citation2017), an EV's high purchasing price is a significant barrier. The high cost of the manufacturing technologies for EVs drives up the cost of the car (Noel et al., Citation2020). The complexity of the battery material (Lithium-ion batteries) employed rises as ongoing attempts and novel technologies are developed to extend the range of EVs

(Biresselioglu et al., Citation2018). The cost of batteries increases as a result (Noel et al., Citation2020).

Lacking networks for charging infrastructure: Lack of a charging station when travelling is another pertinent danger (Krupa et al., Citation2014). Customers frequently ask for the availability of public charging stations to be expanded in order to accommodate the necessity for long-distance driving (Habla et al., Citation2020). Again, the expense of establishing these networks is substantial (Brückmann et al., Citation 2021). The future extension of the infrastructure for charging stations has become questionable as a result of this. The government and EV manufacturers might increase consumer acceptance of EVs by investing in infrastructure facilities (Bhalla et al., Citation2018).Some drivers are frequently discouraged from relying on it because there isn't a reliable charging mechanism. However, there is still considerable disagreement over how much support for EV adoption from the general public in the form of public charging stations. It is probable that adding more charging stations and making them accessible will reassure customers that EVs are a practical option to other forms of transportation (Noel et al., Citation2020). In cities where charging stations are installed and the visibility of EVs raised, it will be crucial to track how public attitudes of EVs develop (Bunce et al., Citation2014).

Concern about the environment as a factor: Urban surface materials, the loss of forests, man-made heat, noise and air pollution, concrete buildings, and the construction of crowded roadways have all been connected to temperature increases in cities (Sampson et al., Citation 2021). The idea that few individuals are significantly impacted by the depletion of natural resources and are thus concerned about environmental protection is further supported by this (Heffner et al., Citation2007; Mohamed et al. Citation2018). The majority of participants did not discover any relationship between their decision to purchase a car and their environmental sentiments until the topic was brought up in organised dialogues, according to a focus group analysis (Flamm & Agrawal, Citation2012). Asadi et al.'s (Citation2021) assertion is thatThe majority of the environmental issues are thought to be addressed by electric automobiles in the future. People and consumers agree that EV adoption would significantly cut pollution (Skippon& Garwood, Citation 2011). Their desire to "live lighter," or use less natural resources, prompts them to purchase an electric vehicle (Ozaki & Sevastyanova, Citation2011; Mohamed et al. Citation2018). This study's Environmental Index was used to gauge respondents' environmental consciousness. Currently, only specific social groups—environmentalists, early adopters, individuals with higher incomes, young urban residents, and tech enthusiasts—use electric vehicles (Axsen et al., Citation2015; Talantsev, Citation2017).In their paper, Skerlos and Winebrake (Citation2010) examine the societal advantages of adopting EVs, including a decrease in GHG emissions and other air pollutants. Considering the emissions from the power plants needed to charge such cars, EVs have demonstrated significantly lower emissions than conventional ICE automobiles. Whether these electric vehicles are powered by coal, natural gas, or renewable fuels will have a significant impact on the size of this disparity.

Factor evaluation: The construction, improvement, and assessment of tests, scales, and measures may benefit from the application of factor analysis, an important tool for data analysis (Williams et al., Citation2010). It is a multivariate statistical technique that is widely utilised in the information system, psychology, business, and educational domains. It is regarded as the preferred method for interpreting self-reporting surveys as well (Bryant et al., Citation 1999).By breaking down a large number of variables (or factors) into smaller sets, factor analysis. It also shows if the constructions are legitimate. It is referred to as a data reduction technique and is used to break down enormous data sets into smaller ones.Exploratory factor analysis is one method taken into consideration in this investigation. To determine if a sample is enough, the Kaiser-Meyer-Olkin (KMO) Test and Bartlett's Sphericity Test are utilised. The KMO test for sample adequacy is advised when the variable to participant ratio is around 1:5 (Williams et al., Citation2012). A 0.5 KMO value for the sample study should be the minimal significant value for moving on with factor analysis, according to the KMO measure of sampling adequacy (Kaiser, Citation1974). The sample can be deemed acceptable when the Bartlett's sphericity test significance value is less than 0.05. KMO and Bartlett's sphericity tests were thus used in this study to assess the suitability of the sample for the factor analysis.Conducting a reliability test on the variables derived from the factor analysis is required to evaluate their internal consistency.

Charging Electric Vehicles Wirelessly: According to J Andersson et al. [8], the use of inductive charging technology can have a significant influence on perceived attractiveness, and as a result, should be a focus in the technology's future development. According to the study, inductive charging will probably result in distinct charging behaviours. No convincing proof that perceived safety should prevent a wider use of inductive charging is the evident advantage.

Energy Use Assistance Tool: The system implementation and measured data for the energy consumption assist function were proposed by Martin Mruzek et al. for electric car energy use assists for extending vehicle range. The technology alerts the driver to any restrictions, such those brought on by bad weather or a low battery level. The clever Energy Usage Assist's function is to communicate with the driver visually and audibly. Data from the battery management system and vehicle control unit will be sent to the energy consumption help. The speed restrictions will be determined by an integrated GPS receiver. Maps system will instruct driver through display based on powertrain evaluated efficiency

INCREASING DEMAND AND SALES

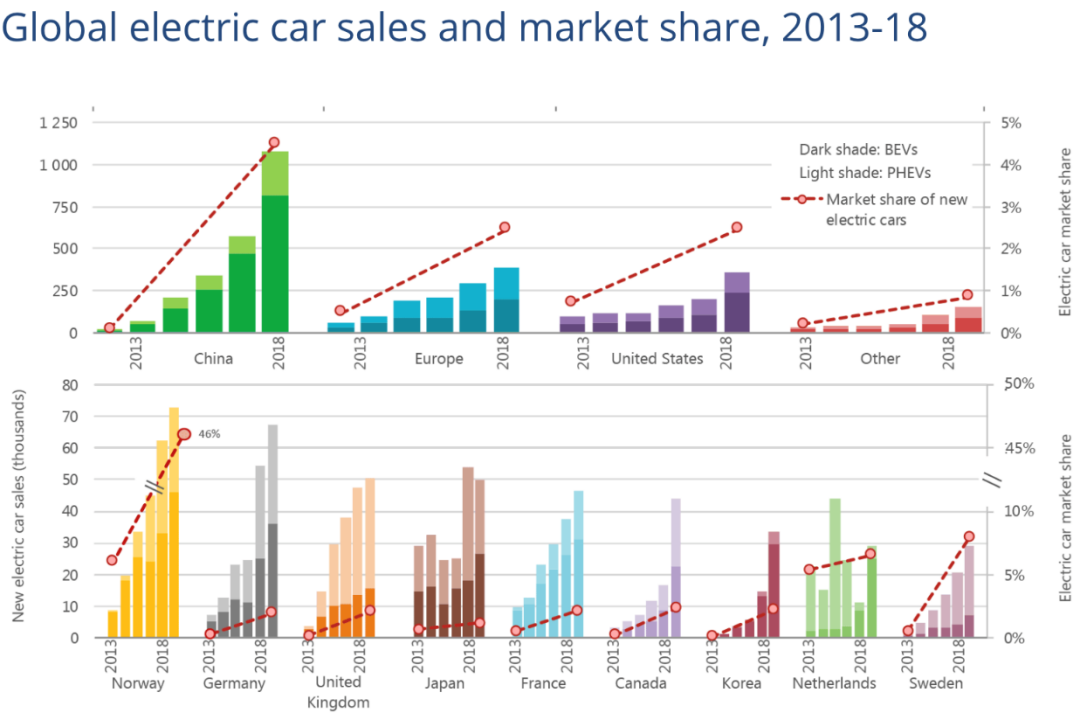
- Electric car sales are expected to reach yet another record level globally this year, increasing their market share to close to one-fifth and bringing about a significant change in the auto industry that will have an impact on the energy sector, particularly oil.
- More than 10 million electric vehicles were sold globally in 2022, according to the latest edition of the IEA's annual Global Electric Vehicle Outlook, and sales are projected to increase by another 35% this year to reach 14 million. According to the most recent IEA

predictions, this fast growth has resulted in an increase in the percentage of electric cars in the entire auto industry from 4% in 2020 to 14% in 2022 and is expected to reach 18% this year.

- "Electric vehicles are one of the driving forces in the new global energy economy that is emerging rapidly - and they are bringing about a historic transformation of the car manufacturing industry worldwide," said IEA Executive Director Fatih Birol. "The trends we are seeing have a big impact on the world's demand for oil. Electric cars are challenging the dominance of the internal combustion engine, which has been unmatched for more than a century. They will save at least 5 million barrels of oil per day by 2030. Electric buses and trucks will soon follow cars as the next wave.
- Three markets—China, Europe, and the United States—have seen the vast bulk of electric car sales to date. China is the market leader, accounting for 60% of all electric vehicle sales worldwide in 2022. China now has more electric vehicles on the road than any other country. The second- and third-largest markets, Europe and the United States, both had rapid growth in 2022, with sales rising by 15% and 55%, respectively.
- This decade and beyond, it is anticipated that ambitious governmental initiatives in major countries, like as the Fit for 55 package in the European Union and the Inflation Reduction Act in the United States, would significantly raise the market share for electric cars. By 2030, Around 60% of all new automobile sales in China, the EU, and the US are expected to be electric vehicles.
- The promising developments are also having beneficial spillover effects on supply chains and battery manufacturing. According to the IEA's Net Zero Emissions by 2050 Scenario, the announced battery manufacturing facilities will produce more than enough batteries to fulfil demand for electric vehicles until 2030. China dominates the battery and component trade and increased its share of the world's exports of electric cars to more than 35% last year, but production remains heavily concentrated.
- Other nations have made plans to support local sectors that will increase their ability to compete in the EV market in the coming years.
- Nearly 90% of the yearly battery demand is expected to be satisfied by domestic battery producers, according to the EU's Net Zero Industry Act. Similar to this, the US Inflation Reduction Act emphasises the development of domestic supply chains for minerals, EVs, and batteries. The Inflation Reduction Act was approved in August 2022, and between that time and March 2023, major EV and battery producers announced investments in North American EV supply chains worth at least USD 52 billion.
- Despite the fact that manufacture and sales of electric vehicles are concentrated in a small number of major markets, other areas are showing promise. Despite starting from a low basis, electric car sales more than quadrupled in India, Indonesia, and Thailand last year.

- In Thailand, it increased to 3% of all sales, while it increased to 1.5% in India and Indonesia. Future increases in these proportions are probably due to a mix of efficient policy and private sector investment. In India, the government's USD 3.2 billion incentive plan, which has drawn USD 8.3 billion in investments, is anticipated to significantly increase battery manufacturing and EV adoption in the upcoming years.
- In emerging and developing economies, two- or three-wheel vehicles, which outnumber cars, are the most dynamic form of electric transportation. For instance, the registration of more than half of three-wheelers in India in 2022 was an electric vehicle, indicating their rising popularity. Two- or three-wheelers are often an accessible form of transportation in underdeveloped nations, therefore electrifying them makes sense.

India's E-Vehicle Plan: Zero tailpipe emissions and a decrease in smog in cities are benefits of electric cars. With a target of 30% EV penetration by 2030, the Indian government has generated momentum with its Faster use and Manufacturing of (Hybrid &) Electric cars initiatives, which both promote and, in some cases, enforce the use of electric cars (EV). The plan encourages the construction of charging stations and technology in metropolitan areas while creating incentives for EV demand. If these goals are accomplished by 2030, they are expected to result in lifetime savings of up to 474 Mtoe (million tonnes of oil equivalent) and 846 Mtoe (million tonnes of net CO2 emissions).Several fiscal demand incentives, such as income tax rebates of up to INR150,000 ($2,100) for consumers on interest paid on loans to acquire EVs, have been implemented to encourage the development and use of EVs and charging infrastructure. A customs duty exemption will be implemented to increase lithium-ion cell battery production while lowering costs.



According to a poll conducted by the Economic Times in May 2019, 90% of Indian automobile owners are eager to switch to EVs, assuming the necessary infrastructure is in place. However, just 1% of all vehicles sold in India at this time are electric, and 95% of those sales are of electric two-wheelers.

Players in the automobile sector, as well as providers of batteries, charging infrastructure, and mobility services, have taken a variety of steps to speed up industrial activity. Companies are developing and testing goods that are appropriate for the Indian market, with a particular emphasis on two- and three-wheelers. An initiative called "Mission: Electric" by the Indian taxi business Ola aims to add 10,000 electric rickshaws and autorickshaws to its fleet. Mahindra and Mahindra, a car manufacturer, would invest INR18 billion in EV production over the next three years in order to increase its four-wheeler output. In order to improve their public transport networks, other manufacturers are forming collaborations with governments. The government's aim is still unwaveringly supported by some of the producers of light-weight cars, such Hero MotoCorp, Bajaj Auto, and TVS, but they are now recommending a more cautious, precise, and practical roadmap for the adoption of EVs. The car sector would need to spend an estimated INR 70 billion to comply with the government's new Bharat Standard-VI pollution laws, and with the requirement to replace traditional internal combustion engines over the next five years, businesses are already feeling the financial pinch. Battery producers like Amara Raja are actively working to improve their research and development capabilities in order to provide battery packs for electric vehicles. Electric charging stations will be widely dispersed throughout cities thanks to ambitious plans by Indian Oil, National Thermal Power Corporation, and Tata Power.

CONCLUSIONS

Electric vehicle development has faced several challenges along the way, from early development to current deployment. The need to reduce climate change sensitivities and the harmful impacts of vehicle emissions has caused governments to shift their thinking away from using conventional oil to power their cars. Oil is becoming scarce and expensive, which has now given many countries the opportunity to develop strategies for the use of electric vehicles. Numerous technical and theoretical solutions have been regularly posted forth in response to the numerous on-road circumstances and scenarios related to e-vehicles that have been examined. The journal article ends on a hopeful note, predicting that concepts for electromobility and sustainable energy production would eventually result in a world without pollution.

REFERENCES

[1] All fossil fuel reserve and consumption data from CIA World Factbook.
[2] www.natef.org
[3] Taeseok Yong, Chankook Park: A qualitative comparative analysis on factors affecting the deployment of electric vehicles (Energy Procedia(ELSEVIER), Volume 128, September 2017, Pages 497-503)
[4] Martin Mruzek*, Igor Gajdáč, ĽubošKučera, DaliborBarta: Analysis of Parameters Influencing Electric Vehicle Range (Procedia Engineering, Volume 134, 2016, Pages 165-174)
[5] (Volume: 59, Issue: 2, Feb. 2012)

[6] Xinmei Yuan, Chuanpu Zhang, Guokai Hong, Xueqi Huang, Lili Li: Method for evaluating the real-world driving energy consumptions of electric vehicles (Energy(ELSEVIER), Volume 141, 15 December 2017, Pages 1955-1968)
[7] J. Wang et al.,: Impact of Electric Vehicle Charging Mode on Load Characteristic in the Shandong Electric Power Grid, (Advanced Materials Research, Vols. 608-609, pp. 1582-1586, 2013)
[8] Jonas Andersson, Maria Nilsson,StefanPettersson: Introducing Wireless Charging for Drivers of Electrical Vehicles in Sweden—Effects on Charging Behaviour and Attitudes. (Advances in Human Aspects of Transportation pp 951-962)
[9] Khalil Salah, Nazri Kama: Inter-service provider charging protocol: a solution to address range anxiety of electric vehicle owners (Energy Procedia Volume 136, October 2017, Pages 157-162)
[10] Cheng Lin, Shengxiong Sun, Wenfei Jiang: Active anti-jerking control of shifting for electric vehicle driveline (Energy Procedia, Volume 104, December 2016, Pages 348-353)
[11] www.theicct.org

CHAPTER-3.11

Modern Indian Lighting Scenery

Jaydeep Dobhal[1], Rajesh chamoli[2], Deepak Kr. Verma[3]
[1,2]Lecturer (EE) JBIT Dehradun, India
[3]Asst. Professor, JBIT Dehradun, India
jj.66ee08@thdcihet.ac.in, rc18ee39@thdcihet.ac.in

ABSTRACT*: By consistently introducing new, more effective technologies, by updating and enhancing lighting design, and by developing a more successful overall system approach, the lighting industry has kept up with these expectations and goals. From Edison's light source to today's energy-efficient, task-oriented economic offer, lighting has advanced over the past century. By producing more energy-efficient products and collaborating with the government to carry out different schemes and awareness programmes, the lighting industry has further launched to reduce energy consumption for lighting from the current 18% of total power consumption to 13% by the year 2020. The business has always made sure that all items are produced in India.*

Keywords- SLNP, UJJALA, and LEDs

INTRODUCTION

Around 20% of all energy usage in India is accounted for by the lighting sector. The government has implemented numerous policies and programmes to create a robust environment for energy-efficient lighting, driven by the climate change targets ratified by India at COP21. One example of this transformation in the lighting market is the government initiative to replace all conventional lights, including the highly inefficient incandescent bulbs, with smart and energy efficient LEDS under the unnat jyoti by affordable LEDs for all (UJALA) programme.

SLNP

The government has committed to replacing 35 million street lights with energy-efficient LEDs by 2019 as part of the street light national programme (SLNP), a crucial part of UJALA. Due to the patchy implementation of street lighting systems in rural areas and the prevalence of inefficient systems in urban areas, there is a need for a complete overhaul of street lights. The SLNP seeks to cut the amount of power needed for street lighting from 3400 MW to 1400 MW, a reduction that will save Rs 55 billion annually. Almost 1.5 million street lights have been replaced with energy-efficient LEDs in 20 states as of December 9, 2016, resulting in energy savings of up to 489.7 MWh or 44.52 MW in avoided demand per day. Under the SLNP, the cost of replacing street lights is borne upfront by EESL repayable by the urban local bodies (ULBs) over a period of five to seven years. Out of the 302 ULBs, this project has already been implemented in six ULBs, and there are another 88 ULBs where work is now being done. With the correct encouragement, the SLNP will be able to further enter rural regions, which not only require energy-efficient systems but also street lighting.

UJALA

In order to start replacing current bulbs with LEDs, the UJALA scheme was launched in January 2015. It was designed to replace about 770 million incandescent lights, and it launched a nationwide push for energy saving. The plan's two goals are to create LED bulbs for less money than the market would bear and to sell them to domestic customers. In order to achieve this, Energy Efficiency Services Limited (EESL), a super energy services company supported by the government, has developed a business model in which it purchases a significant amount of LED bulbs from private manufacturers through competitive bidding and sells them through distribution centres at prices significantly below market prices. Customers can pay for these bulbs either through a bill-financing model (partially upfront and then in installments) or by paying them in full up front. The price of LEDs has significantly decreased over the course of EESL's procurement rounds, going from Rs 310 per bulb in January 2014 to Rs 38 per bulb in the most recent round of bidding in September 2016.Additionally, the market has grown phenomenally; in 2014–2015, just 3 million LED bulbs were delivered, but in 2015–2016, that number reached 150 million, with about 90 million of them going to UJALA alone. More than 180 million LEDs had been dispersed across 22 states as of December 2016. In addition to its two main goals, UJALA also aims to reduce the pick demand of discoms. As of December 9, 2016, this plan has helped reduce grid load by around 4703 MW. In addition to its two main goals, UJALA aims to reduce the pick demand of discoms. As of December 9, 2016, the initiative has contributed to a reduction of around 4703 MW in the load on the grid. Through these activities, 23 million kWh of energy are saved annually, saving Rs 93 billion and reducing CO2 emissions by 19.2 million tonnes.

With the replacement of 770 million bulbs, the country's connected load would be reduced by an estimated 20,000 MW, yielding annual energy savings of 100 billion kWh. With an average electricity tariff of Rs 4 per kWh, the total amount of money consumers would save on their electricity bills would be close to Rs 400 billion. The final costs of bulbs vary across states and are typically in the range of Rs 75–95 per bulb as a result of various state-specific taxes and other administrative costs like distribution that are added to the pooled procurement price.

CONCLUSION

According to the electrical lamp and component manufactures association, UJALA has had a significant impact on the lighting market. The LED market has grown by 579 percent from 2010 to 2014 and is currently worth Rs 33.95 billion. It is predicted to reach at least Rs 50 billion by 2016-2017. In addition, India's share of the global LED market has increased from 0.1% to 10%.

In conclusion, market-driven efficient procurement methods and low procurement prices under UJALA have assisted customers in overcoming the price barrier, monetizing energy savings, and drawing in investments.

REFERENCES

[1] Prasad Bhukya, Dr. Debasish Basak, Energy Saving Technologies in Industries- An overview, International Journal of Scientific and Research Publications, Volume 4, Issue 4, April 2014 ISSN 2250- 3153.
[2] M. Yang, Closing the Gap,DOI: 10.1007/978-1-4471-4516-5_2,World Bank 2013.
[3] Mr. Jeremy Snyder, Advancing the effective use of light for society and environment. —Volume 2
[4] Malkiat Singh, Gurpreet Singh, Harmandeep Singh, ENERGY AUDIT: A CASE STUDY TO REDUCE LIGHTING COST, 5 (2012) 119 – 122.
[5] Abhishek Garg and Rajasekar.S, "A New Modulation Technique to Eliminate Leakage Current in Transformerless PV Inverter", Engineering and Systems (SCES), 2013 Students Conference .
[6] G. Buticchi et al, "Compensation Strategy of Actual Commutations for PV Transformerless Grid-Connected Converters", Electrical Machines (ICEM), 2010 XIX International Journal.
[7] D. Barater et al, "A new proposal for ground leakage current reduction in Transformerless Grid-Connected Converters for Photovoltaic Plants", Industrial Electronics, 2009. IECON '09. 35th Annual report.

CHAPTER-3.12

Method of Choosing a Transformer Rating Using Life Cycle Cost Analysis

Jaydeep Dobhal[1], Rajesh chamoli[2], Deepak Kr. Verma[3]
[1,2]Lecturer (EE) JBIT Dehradun, India
[3]Asst. Professor, JBIT Dehradun, India
jj.66ee08@thdcihet.ac.in, rc18ee39@thdcihet.ac.in

ABSTRACT*: The improving efficiency in transformers represents a significant gain as almost one third of network losses are caused by inefficient transformers. In addition, reduced energy losses, high efficiency transformer provides benefits of reduced greenhouse gas emission, increased reliability and longer service life of the equipment. The energy-efficient transformer technology has been available for decades, but its high upfront costs deterred wide-scale penetration. Given this, most major economies across the world have established and introduced minimum energy performance standards for distribution transformers.*

Keywords- transformer, leading wires

INTRODUCTION

A transformer is unique equipment, where efficiency improves with decreased loading, up to a certain loading. This is because the load losses in a transformer vary as a square of the load current. However, this will hold good only up certain loading. This is the loading where iron losses become equal to copper losses.

CASE STUDY

Consideration for analysis: The life of transformer is considered as 25 Years. The losses as per IS1180 are considered for loss cost calculation (for energy efficiency Level 1). The same are calculated as below:

I. 1.6MVA- Total loss at 100 per cent load =14.51Kw.
II. Total loss at 50 per cent load=4.84kW.
III. Sample calculation for no load loss and full load loss calculations for 1.6 MVA transformer P Total =P no load+ (load percentage / 100) 2× P load

Calculated no load loss-1.61 KW

Calculated full load loss-12.9 KW

Similarly, for a 2 MVA transformer, calculated no load loss-1.65 kW and calculated full load loss-16.62 kW

Transformer running cost (loss lost) is calculated for three shifts working, considering350 days of yearly operation and eight working hours per shifts. For the first year of operation, the per unit cost is considered as Rs 10 per kWh. Increase in utility company tariff is considered@ 5 per cent annum over the next 25 years.

Payback period is calculated with interest loading on saving in capex/opex and it will vary based on:

I. Hours of operation
II. Actual loading
III. Per unit (kWh) power cost
IV. Interest rate

For an option with a higher rating of transformer, as a different cost in initial investment, only the increased cost of a higher rating transformer is considered.

The cost towards its 415 V power control centre income, associated bus dust and outgoing feeders will remain unchanged since the load to be distributed remainas same in any of the option.

Load cycle for 1.5 MVA demand over a span of 24 hours is considered as mentioned in Table1.

TABLE -1						
MD (%)				70	90	100
Work hours						
Total hours	24					

Operation and maintenance costs are not considered in the analysis since they are considered to be almost the same for both the options.

(1) Life cycle cost comprises the initials investment and the running cost due to energy losses in the transformer.

ANALYSIS OF LIFE CYCLE COSTANALYSIS TRANSFORMER RATING

The transformer sizing is analyzed considering the following configurations:

(1) Option1-1×1.6MVA,33/0.415KV

(2) Option2-1 ×2MVA, 33/0.415KV

OPTION1: For a demand variation between 40 percent and 100 percent during a 24- hour cycle, the loading on transformer will vary from 38 percent to 94 percent and according to the loading, the load loss will also vary. A sample calculated of the life cycle cost is as follows:

Step1: Calculations of initial investment Cost of 1.6MVA transformer =Rs2.31million

Total cost of initial investment =Rs2.31 million

Step2: Calculation of running cost

Step2a: Calculation of the percentage loading of a transformer as per the actual demand is an mentioned in Table2

Step2b: The losses for the different percentage loading of transformers are as mentioned in table 3.

Step2c: Sample calculated for annual loss cost for 56 percent loading of transformers:

Loss cost = Total losses for 56 percent loading × Annual working hours for 56 percent loading× power tariff rate

TABLE-2						
MD (%)	40	50	60	70	90	100
Demand during these working hours (MVA)	0.60	0.75	0.90	1.05	1.35	1.50
Loadingof transformer (%)	38	47	56	66	84	94

Table -3						
% loadingof transformer	38	47	56	66	84	94
No loadloss (Kw)	1.61	1.61	1.61	1.61	1.61	1.61
Full loadloss (Kw)	1.81	2.83	4.09	5.57	9.21	11.35
Total loss (Kw)	3.42	4.45	5.71	7.19	10.81	12.97

Equation 1

Loss cost for the first years = 5.69 × (4 ×350) × 10

= Rs.79,000

Loss cost for the second years =5.69 × (4× 350) × 10.5

= Rs.84,000

So, consideration a 5 percent increase in tariff rate per years, for period of 25 years, the loss cost for the 25th years = 5.69× (4 × 350) × 32.3

= Rs 256,000.

Total loss cost for 25 years = Rs 3.8 million

Similar to equation 1, the total loss cost for the first years

= ∑{Total losses for (38% / 47% /56% / 66% / 84% / 94 %) loading × Annual working hours [(6/3/4/8/2/1) × 350] × power tariff rate for the first years }

= Rs 520,000

Based on this calculation the summary of the annual loss cost for option 1 is mentioned in table 4.

Table-4						
% loading of tran	38	47	56	66	84	94
Cores. loss cost for 25 years (Rs in million)	3.43	2.22	3.80	9.57	3.60	2.16
Total loss cost for 25 years (Rs.	24.81					

Step 3: Calculation of life cycle cost

Life cycle cost = cost of initial investment+ load loss cost

= Rs.2.31 million + 24.8 million

= Rs.27.11 million.

OPTION 2

Similarworking is carried out for 2MVA transformers.

Comparison of option 1 and 2

A comparison of option 1 and 2 indicated in table 5.

Table-5			
COST (Rs million)	Option 1	Option 2	Difference
Capital cost	2.311	2.480	-0.175
Operational loss cost for 25 Years (Rs in million)	24.806	21.745	+3.059
Life cycle cost	27.117	24.2321	

The lifecycle cost mentioned in table 5 is without interest rate consideration on initial saving in the capital cost as well as without any interest loading on the loss cost saving (due to option for higher size, that is 2MVAtransformer instead of 1.6MVA transformer).

CALCULATION WITH INTEREST LOADING

Calculation for total saving in the initial investment in option 1: saving =P×(1+R/100)N where ,P = Principal amount (saving of Rs 17,5000) R, Rate of interest @ 8 percent annul , N= no. of years =25 years , saving= Rs = 1.198 million.

CALCULATIONS FOR TOTAL SAVING IN THE LOSS COST FOR OPTION 2

Saving at the end of the first years = Loss cost of 1.6 MVA- Loss cost of 2.0 MVA= Rs 520,000-Rs

456,000= Rs 64,000 saving at the end of the second years = (Loss cost of 1.6 MVA-Loss cost of 2.0 MVA) + Interest on the first year's savings =(546,000- 478,000)+ (64,000×1.08)= Rs 137,000.

At the end of the 25th years, there will be net saving of Rs 6.2 million (7.398-1.198 = 6.20).

CONCLUSION

If the transformer size calculated for a maximum demand (MD) of 1.5MVA is 1.6MVA, on a life cycle cost analysis basis, a 2 MVA transformer will be advantageous. The payback period will be 3.5 years. The analysis will not be applicable for a group of transformers selected on the redundancy philosophy. The accuracy in the load estimation and load pattern will play a key role in the analysis.

REFERENCE

[1] Canadian Electrical Association Technology Seminar, "Life Cycle Management of Power Transformers, "Toronto, Canada, November 20-21 1995.
[2] R. Reason, "On-Line Transformer Monitoring," Electrical World, , pp. 19-26, October 1995.
[3] W. Morse, N. Di Maria, "New Tests for Transformer Oil,", Electricity Today, Vol. 7, No. 5, pp. 25-27, May1995.
[4] B. Gupta, W. McDermid, G. Polovick, V. Shenoy, G. Trihn, "Transformer Insulation Aging: A Review of the State of the Art," Electricity Today, Vol. 7, No. 5, pp. 18-24, May 1995.
[5] AANSI/IEEE Standard C57-1981: Guide for Loading Mineral-Oil-Immersed Power Transformers.
[6] W.J. McNutt, "Considerations for Overloading Transformers above 100 MVA," Proceedings of the American Power Conference, Vol. 41, pp. 1226-1230, 1979.
[7] Pierce, "Improved Equations for More Accurate Hot-Spot Temperature Prediction in Transformers, "Electricity Today, Vol. 7, No. 5, pp. 29-31, May 1995.
[8] IEEE Standard C57.115-1991: Guide for Loading Mineral-Oil-Immersed Power Transformers Rated in Excess of 100 MVA Canadian Electrical Association Report 355T822, "Application of Fiber Optic Temperature Sensors to Establishing Transformer Overload Capabilities.," 53 pages, March 1995.
[9] Environment Canada Winnipeg Climate Centre, "Temperature and Precipitation Normals and Extremes -1994 Comparative Data."
[10] Y.G. Bae, P.W. Adkins, D.W. Bree, "Quantitative Evaluation of the Cost and Benefits Associated with Transformer Loading," IEEE Transactions on Power Apparatus and Systems, Vol. PAS-98., No. 1, pp. 159- 164, Jan/Feb 1979.

CHAPTER-3.13

A Summary Theory and Research Gap of Household Electricity Demand

Jaydeep Dobhal[1], Deepak Kr. Verma[2]
JB Institute of Technology Dehradun, India
jj.66ee08@thdcihet.ac.in

ABSTRACT: *Theory and Research gap regarding the relationship between demographic/household characteristics and household electricity demand need to be studied. Several findings show that demographic/ household characteristic factors are very important for the determinant of household electrical energy demand. This article is intended to clarify how demographic/household factors influence household electricity demand so that a better model of household electricity demand is obtained.*

Keyword- Electricity demand

INTRODUCTION

The theory of demand departs from the demand function which illustrates that the amount of goods consumed is a function of total income and the price of goods expressed in the form of utility maximization. Utility maximization can be explained using Marshallian demand theory, where consumers are assumed to maximize utility functions by considering budget constraints (Christensen et al, 1975; Cooper and McLaren, 1992; Koutsoyiannis, 1994). Furthermore, in household energy demand, Kurtubi (1998) argues that in maximizing energy utilities not only consider budget constraints, but also consider income factors, energy prices, and other energy prices that can use static and dynamic models. Likewise, the electricity demand model cannot be viewed only by maximizing utility with budget constraints or with the stock of electrical equipment used. Guertin et al (2003) and Halvorsen et al (2003) offer that in estimating household electrical energy demand must also consider demographics and household characteristics that can affect the functioning of household utilities.In addition to budget constraints, stock of electrical equipment, as well as demographic/ household characteristics, one of the important factors that is often debated in modeling the demand for household electricity is the proxy for electricity prices or tariffs, whether using average prices or marginal prices. This is caused by different tariff setting structures between increasing block rates and decreasing block rates. Taylor (1979) and Schafer (987) offer marginal price proxies to avoid simultaneous symptoms due to different price structures, but these proxies were denied by Halvorsen (1975), Wilder & Willenborg (1975), Henson (1984), and Zuhal (1995). However, several studies have offered a willingness to pay (WTP) model as a proxy for prices, especially for public goods (Hokby & Soderqvist, 2001; Anstine, 2001; PSE-KP UGM, 2002; Nam & Son, 2005; Wang & Son Whittington, 2006).

For an example, In Indonesia, the consequences of electricity price/tariff policies implemented by PT PLN (Persero) in a monopoly with an increasing block-rate pricing system shows that electricity prices/tariffs do not have price variations and consumers can

only accept prices/tariffs charged to them. Therefore, the electricity price/tariff factor determined by this monopoly cannot be included in the household electricity demand estimation model. Therefore, in this case, electricity price/tariff factors are proxied by the willingness to pay. Many factors affect the demand for electrical energy. The pattern and amount of electricity used will be different for each group of consumers depending on two factors, namely 1) for what object the electrical energy is used, and 2) the time of use (hours load) (Philipson and Willis, 1999). Fluctuations in electricity demand from customer groups, both those related to the amount of power, as well as those concerning time, are influenced by several factors such as 1) weather, 2) the seasonal industry and entertainment areas, 3) the presence of important events (Kadir, 2000). More broadly, according to Nagurney and Arneaux (1991), the factors that influence the demand for electricity are economic conditions, usage time on a daily or weekly basis, weather conditions, attitudes towards conservation, population, television use, regulatory environment, electricity prices, technology, alternative energy, and demographic conditions. In general, for all groups of electricity consumers, the factors that can affect electricity demand or demand are 1) consumer income, 2) electricity tariff or price, 3) electricity availability, 4) price of substitute energy and 5) equipment ownership, price, and efficiency in the use of electrical equipment (PT PLN Wilayah Sumut, 2004).

The most basic main variables that affect household electricity demand are household income, the price (tariff) of electrical energy, and the stock / number of electrical equipment (Anderson, 1973; Wilder & Willenborg, 1975; Acton et al., 1980; Fujii & Mak, 1984; Jaffee et al, 1982; Terza, 1986, Filippini, 1995; Halvorsen & Larsen, 1999a, 1999b; Matsukawa, 2000; Langmore & Dufty, 2004). In addition to these variables, several other studies have included demographic and household characteristics variables in estimating household electrical energy demand, as done by Taylor, (1979), Barnes et al (1981), Archibald et al, (1982) , Maddigan et al. (1983), Garbacz (1984), Reiss & White (2001); Larsen & Nesbakken (2002), Halvorsen et al (2003). Several other researchers have also included other types of energy such as firewood, fuel oil, and gas in the electric energy demand model as a substitution variable (Maddigan et al, 1983; Halvorsen et al, 2003; Langmore & Dufty, 2004).

On the other hand, the analysis of electric equipment stock variables does not only look at the numbers, but also emphasizes the use (intensity of appliances, utilization rate, or end use categories). This has been done by Hartman (1983), Bartels & Fiebig (2000), Reiss & White (2001), Guertin et al (2003), Meetamehra (2004). Other studies such as those conducted by Battalio et al (1979), Shin (1984), Sexton & Sexton (1987), Matsukawa (2004) have analyzed how information influences electricity demand. The information includes information regarding demand response about prices, the role of government, energy conservation and patterns of energy use.

The above studies use a lot of primary data and use a single equation form demand function, for example Taylor (1979), Archibald et al (1982), Jung (1993), Filiplini (1995), Halvorsen &

Larsen (1999), Matsukawa (2000)), Reiss & White (2001), Larsen & Nesbakken (2002), Filippini & Pachauri (2002), Halvorsen at al (2003). Meanwhile, estimates in the form of simultaneous equations were made by Wilder & Willenborg (1975), Barnes et al (1981), Jaffee et al (1982), Maddigan et al (1983), Garbacz (1984). Some other studies such as Acton et al (1980), Maddigan et al (1983), Filippini (1999) use secondary data in estimating the function of household electrical energy demand.

The description above shows the incomplete factors that affect household electricity demand. Some differences of opinion or findings as a research gap in this study, especially regarding the relationship of demographic / household characteristics and household electrical energy demand need to be examined. Several findings as described above show that the demographic / household characteristics factors are very important for the determinants of household electrical energy demand. This research is intended to clarify how demographic / household factors affect household electricity demand, so a better model of household electricity demand is obtained. Research on electricity demand in Indonesia, especially for households is still limited. Amarullah (1984) conducted a study of household, industrial and business groups using pooled data and secondary data for the period 1970 - 1979 using limited independent variables, namely income (income per capita, output), average electricity prices and the number of people who have access to electricity. Meanwhile, Tarigan et al (2002) analyzed household electrical energy needs for the North Sumatra region using time series data for the period 1980 - 2000.

The independent variables used were real income per capita, real prices for electricity, and number of customers. Likewise, with Tarigan (1998) has made forecasting the need for electrical energy for groups of households, public, industry, business, and for the peak load of the period 1998 - 2007 for the city of Medan using cross-section data. The independent variables used are the number of customers per group, GRDP, and the price of electricity for each group.

CONCLUSION

All of the above studies still estimate the demand or the electrical energy needs of the household group as a whole. Whereas consumer groups in Indonesia are different because each customer group is still classified into several strata based on connected power and electricity tariffs, each of which has different characteristics. Household consumer groups are also still classified into six strata, namely: R-1 / TR 450VA, R-1 / TR 900VA, R-1 / TR 1300VA, R-1 / TR 2200VA, R-2 / TR> 2200VA -6600VA, R-3 / TR> 6600VA. Research conducted in Indonesia, specifically in Medan City, so far, still uses secondary data obtained from BPS (Statistic Board of Indonesia). Hopefully, this article is useful for readers in analyzing the factors that can affect the electrical energy demand of household customer groups. This article is also expected to stimulate the readers in formulating a model of electricity demand which in turn can be used as a model in making decisions about household electricity systems in the future.

REFERENCES

[1] Acton, J. P., Bridger M. Mitchell, and Ragnhild Sohlberg, 1980, "Estimating Residential Electricity Demand under Declining-Block Tariffs : An Econometric Study Using Micro-Data", Applied Economics, Vol. 12, 1980, pp. 145-161.
[2] Amarullah, M., 1984, "Electricity Demand in Indonesia : An Econometric Analysis",
[3] Publikasi LMK, No. 01-EP-84, Pusat Penyelidikan Masalah Kelistrikan, PLN, Jakarta.
[4] Anderson, K. P., 1973, "Residential Demand for Electricity : Econometrics Estimates for California and the [4]United States", Journal of Business, Vol. 46, Issue 4, October 1973, pp. 526-532.
[5] Anstine, D. B., 2001, "How Much Will Consumers Pay ? A Hedonic Analysis of the Cable Television Industry", Review of Industrial Organization, Vol. 19, pp. 129-147.
[6] Archibald, R. B., David H. Finifter, and Carlisle E. Moody Jr, 1982, "Seasonal Variation in Residential Electricity Demand : Evidence from Survey Data", Applied Economics, Vol. 14, 1982, pp. 167-181.
[7] Barnes, R., Robert Gillingham, and Robert Hagemann, 1981, "The Short-run Residential Demand for Electricity, The Review of Economics and Statistics, Vol. 63, Issue 4, November 1981, pp. 541-552.
[8] Bartels, R., and Denzil G. Fiebig, 2000, "Residential End-Use Electricity Demand : Results
[9] from a Designed Experiment", The Energy Journal, Vol. 21., No. 2, 2000, pp. 51-81.

CHAPTER-3.14

Fast and Efficient Division Technique Using Vedic Mathematics in Verilog Code

Kundan Singh Chauhan[1], Deepak Kr. Verma[2]
JB Institute of Technology Dehradun, India
kundan1984chauhan@gmail.com

ABSTRACT: *Division is the most fundamental and commonly used operations in a CPU. These operations furthermore form the origin for other complex operations. With ever increasing requirement for faster clock frequency it becomes essential to have faster arithmetic unit.In this paper a new structure of Mathematics – Vedic Mathematics is used to execute operations. In this papermainly algorithm on vedic division technique which are implemented for division in Verilog and performance is evaluated in Xilinx ISE Design Suite 13.2 platform then compared with different parameters like delay time and area (number of LUT) for several bits algorithms.*

Key words- Vedic mathematics, multiplication, division,delay time, Verilog.

INTRODUCTION

Division is an important essential function in arithmetic operations. Multiplication-based different operations considered as Multiply and Accumulate (MAC) and internal product are among some of the commonly used Computation- Intensive Arithmetic Functions (CIAF) presently implemented and designed in many Digital Signal Processing (DSP) appliances considered as convolution of two or more than two information, Fast Fourier Transform (FFT) of different sequences, filtering of signals or information and in microprocessors its used in arithmetical and logical unit (ALU) [1]. Since multiplying is the most important factor for the implementation time for most of the DSP algorithms or techniques, there is a need of most efficient and high-speed division. Currently, division time is still the most important factor in determining the instruction cycle time and the delay time of a DSP chip.

The requirement for high-speed processing has been growing as a result of increasing work for computer and signal processing applications. Higher throughput arithmetical and logical operations are important to accomplish the required performance in various real-time signal and image processing applications [2]. The main key of arithmetical and logical operations in these applications is multiplication and division techniques and the development and designing of fast and efficient multiplier circuits has been a subject of interest over the last few years. Sinking the execution time and power consumption of required circuits are very necessary requirements for various applications such as in digital signal processing and in digital image processing [2, 3]. This work presents different division techniques and architectures. Multiplier based on Vedic or ancient Mathematics is one of the fastest and efficient with low propagation delay and low power consumption multiplier.

Vedic Mathematics: Vedic Mathematics introduces the magnificent applications to Arithmetical calculation and verification, theory of numbers, complex multiplications,

fundamental algebraic operations, complex factorizations, simple quadratic and advanced order equations, concurrent quadratic equations, partial fractions, in differential calculus and integral calculus, squaring of complex number, cubing, square root of complex number, cube root, 2-Dimensional and 3-Dimensional coordinate geometry and brilliant Vedic Numerical code.

(a) Vedic Mathematics Sutras and Up-sutras: Entire mechanics of Vedic mathematics is based on 16 sutras – formulas and 13 up-sutras meaning – corollaries.

Sutras

1. Ekadhikena Purvena
2. Nikhilam Navatascharamam Dashatah
3. Urdhva-tiryagbhyam
4. Paravartya Yojayet
5. Shunyam Samyasamucchaye
6. Anurupye Sunyamanyat
7. Sankalana vyavakalanabhyam
8. Puranaprranabhyam
9. Calana – Kalanabhyam
10. Yavadunam
11. Vyastisamashtih
12. Sheshanynkena Charmena
13. Sopantyadvayamantyam
14. Ekanyunena Purvena
15. Ginitasamucchayah
16. Gunaksamucchayah

Up-sutras

1. Anurupyena
2. Shishyate Sheshsamjnah
3. Adyamadye Nantyamantyena
4. Kevalaih Saptakam Gunyat
5. Vestanam
6. Yavadunam Tavadunam
7. Yavadunam Tavadunikutya Varganka ch Yojayet
8. Antyayordhshakepi
9. Antyatoreva
10. Samucchayagunitah
11. Lopanasthapanabhyam
12. Vilokanam
13. Gunitasamucchyah Samucchayagunitah

(b) Urdhva-tiryagbhyam: The Nikhilam and Anurupyena are for special cases, whereas Urdhva-tiryagbhyam is general formula applicable to all [4]. Its algebraic principle is based on multiplication of polynomials. Consider we want to multiply two 4thdegree polynomials.

$$Ax^4+ Bx^3+ Cx^2+ Dx + E$$

$$Zx^4+ Yx^3+ Xx^2+ Wx + V$$

$$AZ\ x^8+ (AY+BZ)\ x^7+ (AX+BY+CZ)\ x^6+ (AW+BX+CY+DZ)\ x^5+(AV+BW+CX+DY+EZ)$$
$$x^4+ (BV+CW+DX+EY)\ x^3+ (CV+DW+XE)\ x^2+ (DV+EW)\ x +EV$$

Figure 1 - Multiplication of two fourth degree polynomials

Highest degree coefficient can be obtained by multiplication of two highest degree coefficients of individual polynomial namely A and Z. A next degree coefficient is obtained by addition of cross multiplication of coefficients of 4th degree and 3rd degree of other polynomials [5]. It means A, which is 4th degree coefficient of polynomial-1 is multiplied by 3rd degree coefficient of polynomial-2 is added to 4th degree coefficient of polynomial-2 multiplied by 3rd degree coefficient of polynomial-1 to get (AY+BZ).

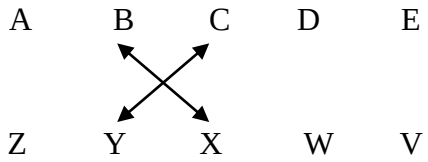


Figure 2 - Vertically Crosswise First Cross Product

Similar logic of cross multiplication and addition can be extended till all 5 coefficients of both polynomials are used as follows. Every iteration gives a coefficient of product.

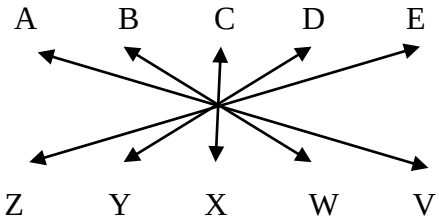


Figure 3 - Vertically Crosswise Intermediate Cross Product

In this iteration, coefficient of degree 4 of product is obtained. For the next iteration we drop A and Z which are the highest degree polynomial coefficients. The resulting operation gives coefficient of the degree 3 of multiplication of polynomials as follows:

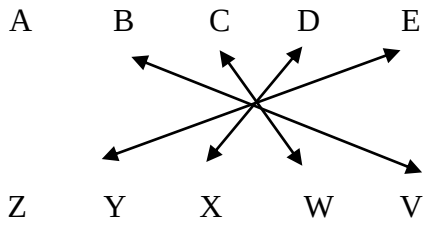


Figure 4 - Vertically Crosswise Intermediate Cross Product

Continuing with this process, the last coefficient is obtained by multiplication of 0th degree terms of both polynomials as E*V. This process can be done both ways as it is symmetric. In summary the process can be stated as, process of addition of product of coefficients of two polynomials in crosswise manner with increase and then decrease in number of coefficients from left to right with crosswise meaning product of coefficients for one polynomial going rightwards while for other leftwards.

Any decimal number can be thought of as a polynomial with unknown or x equal to 10. Being said that the formula stated above can be utilized to calculate the product of two decimal numbers. Each digit of decimal number is thought as coefficient of power of 10. The only restriction in this case is each cross product should be only one digit, if not it is added to the next power of 10.

Proposed Algorithm: The algorithms will be compared to conventional algorithm which is considered as restoring algorithm and/or non-restoring algorithm of division. In restoring algorithm shifted divisor is repeatedly subtracted from dividend and result of subtraction is stored temporarily. The algorithm can be formulated as [6].

$N = Q \times D + R$

Where N dividend, D is divisor, Q is quotient and R is remainder.

Restoring Algorithm

1. R(m) = N m as width of N

2. Repeat for i from m-1 to 0

$Z = R(i+1) - D \times 2i$

If $Z \geq 0$ then Q(i) = 1, R(i) = Z

Else Q(i) = 0, R(i) = R(i+1)

Verilog implements restoring algorithm for its division block. For restoring algorithm worse case N subtractions has to be performed to get N digits of quotient. Each subtraction is equal to width of divisor.

Binary Dhwajanka: In binary number system, similar to decimal system, MSB of divisor is kept aside and remaining digits are used for cross-products [7].

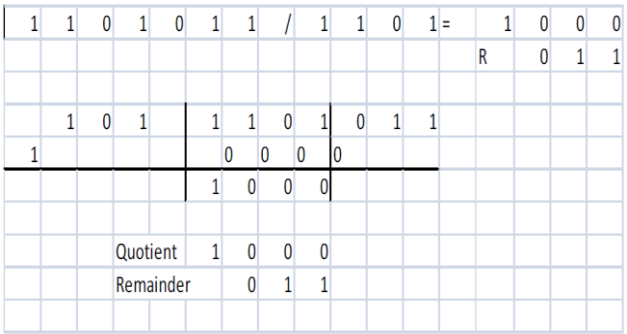


Figure 5 - Complete Example of Dhwajanka

In binary number system, similar to decimal system, MSB of divisor is kept aside and remaining digits are used for cross-products. As digits in binary can only be 0 or 1, the process of Dhwajanka becomes simpler as division has to be carried out with 1 always. Hence MSB of dividend becomes the MSB of quotient. Cross-product is taken between quotient and rest bits. Again, in cross-product digits being only 0 and 1 multiplication is replaced by AND logic. After the addition of cross-product of bits the sum is subtracted from combination of previous remainder and next digit of dividend. In the example above the first bit of quotient is equal to MSB of dividend and hence the remainder is 0. This 0 is combined with the next digit of dividend 1, to form 01. Cross-product of quotient and rest bits of divisor gives 1 as only one bit in quotient at this point of the process. Cross-product is subtracted from partial dividend 01 to get 0. Now when 0 is divided by 1 we get quotient 0 and remainder 0. Quotient 0 of this partial division forms the next bit of quotient and remainder as next prefix [8]. In short, Dhwajanka formula for binary is further simplified by the nature of the binary numbers.

Despite being very easy to solve by Dhwajanka, there are some limitations of the process which will be described in the next section.

3.1.1 Limitations and Solutions: A combinational model of this process was designed in Verilog [9]. The reason to choose combinational method was to compare it with equivalent Verilog implementation block and a sequential model will require varying number of clock cycles to finish the division depending on the input – dividend and divisor. The nature of the problem in building the combinational model and respective solutions on them are described in next sections.

NEGATIVE SUBTRACTION

During the calculation of third bit of quotient partial dividend is 0 and cross-product is 0 which results in negative 1 as partial dividend which is unacceptable according to algorithm. Solution for this is given as recalculate previous iteration with smaller quotient digit to result in sufficiently large partial remainder.

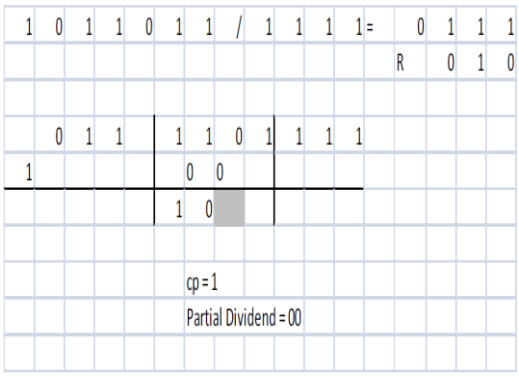


Figure 6 - Dhwajanka – Problem of recalculation

In this case the previous quotient bit being 0, it cannot be further reduced to make remainder bigger. Hence former to this iteration has to be recalculated shown below.

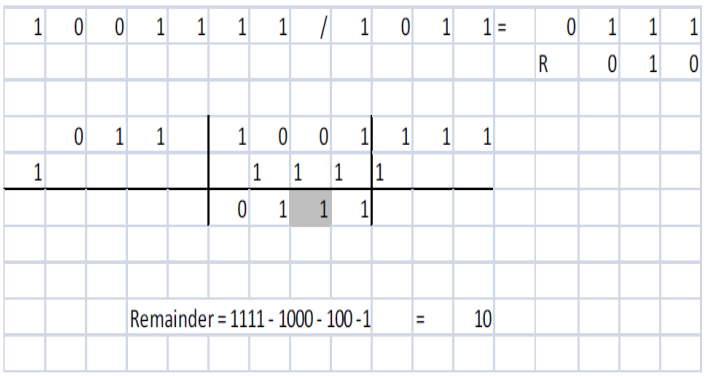


Figure 7 - Dhwajanka – Solution of recalculation

In the case of combinational design reiteration would result in feedback loop which is unacceptable and in sequential design this would lead to a design which is data dependant and hence undesirable. The solution on this is to allow bits of quotient as well as partial remainders to be negative. This obviously is an overhead of calculation as the state of each bit of quotient and partial remainders must be maintained, but this enables us to build a combinational design. The complete illustration is as follows.

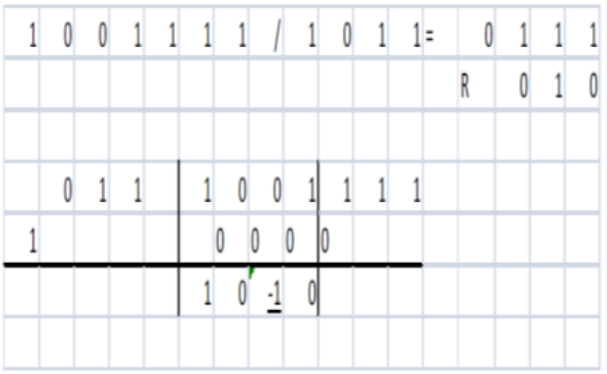


Figure 8 - Dhwajanka – Problem of Negative Quotient

During the calculations of third bit of quotient partial dividend 00 is subtracted by cross-product 01 to get quotient as -1 and next partial remainder as 0. If the subtraction is more than 1 then both the quotient bit and partial remainder would be negative.

CORRECT REMAINDER

There is another problem in the illustration above. While calculating the remainder we subtract cross-products from the right part of dividend prefixed with last partial remainder. Cross-product consists of rest digits of divisor and quotient with first cross-product contains all bits and is also shifted left by one less than bits in rest digits of divisor. If any cross-product is negative, then it is added. If the last partial remainder is negative, then right part of dividend becomes inherently negative. After all the calculations for remainder if it is more than divisor or less than zero it is illegal. Also, it is imperative to have legal remainder to get correct quotient. In the illustration above calculations for remainder are as follows.

	0	1	1		1	0	0	1	1	1	1				
1						0	0	0	0						
					1	0	-1	0							
	Remainder = 0111 - (-100) - (10) =							0111 + 100 + 10 = 1101							
	Correct Remainder = 1101 - 1011 = 0010														
	Quotient = 1000 - 10 = 0110														
	Correct Quotient = 0110 + 0001 = 0111														

Figure 9 - Dhwajanka – Solution for Negative Quotient

Correct remainder is obtained by subtracting divisor from remainder. If the subtraction gives remainder more than divisor, the process is repeated. Above correct remainder is obtained by subtracting divisor once, so correct quotient is obtained by adding 1.

Partial remainder overflow: As the width of dividend and divisor increases, in some cases it is observed that last partial remainder is itself a large number which when combined with right part of dividend becomes a number which may sometimes exceed the width of dividend or divisor itself. This results in large correction logic and hence is undesirable. There can be different approaches to deal with this like checking the correctness of remainder after every 3–4-bit calculation of quotient, use of sequential design model. To check correctness of remainder after every 3-4 bits can work for combinational design but has huge overhead of calculation partial quotient repeatedly and again results is considerably large logic. As seen previously sequential model results in a design which would depend on data to calculate the answer.

RESULTS

SIMULATION RESULTS OF 8 BITS VEDIC DIVISION

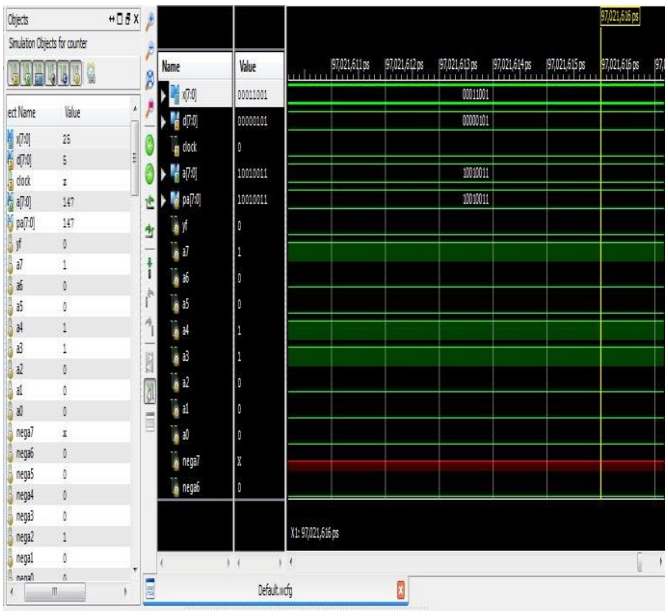


Figure 10 – Simulation result of 8 bits Vedic Division

Description:

x : Input data 8 – bit

d : Input data 8 – bit

clk : Input clock

a : Output data 8 – bit

x = 00011001

d = 00000101

a = 10010011

Thus, simulated result and calculated result match correctly.

SYNTHESIS RESULTS

Device utilization summary:

Selected Device:	3s500efg320-4	
Number of Slices:	248 out of 4656	5%
Number of 4 input LUTs:	450 out of 9312	4%
Number of IOs:	25	
Number of bonded IOBs:	25 out of 232	10%
IOB Flip Flops:	8	
Number of GCLKs:	1 out of 24	4%

Total memory usage is 198936 kilobytes.

Timing Results

Minimum input arrival time before clock:	98.119ns
Maximum output required time after clock:	4.283ns
Total REAL time to Xst completion:	13.00 secs
Total CPU time to Xst completion:	12.90 secs

CONCLUSION

The designs of 8 bits Vedic division have been implemented on Spartan3E (3s500efg320-4) device. The computation delay for 8 bits Vedic division is 98.119ns. It is therefore seen that the Vedic division is much faster than the conventional division for higher order bits. The algorithms of Vedic mathematics are much more efficient than of conventional mathematics. In future this work can be extended to higher bit Division which can be implemented using Vedic Mathematics. Floating Point Vedic Processor could also be a good extension of this work.

REFERENCES

[1] Purushottam D. Chidgupkar and Mangesh T. Karad, “The Implementation of Vedic Algorithms in Digital Signal Processing”, Global J. of Engng. Educ., Vol.8, No.2 © 2004 UICEE Published in Australia.

[2] Himanshu Thapliyal and Hamid R. Arabnia, “A Time-Area- Power Efficient Multiplier and Square Architecture Based On Ancient Indian Vedic Mathematics”, Department of Computer Science, The University of Georgia, 415 Graduate Studies Research Center Athens, Georgia 30602-7404, U.S.A.

[3] E. Abu-Shama, M. B. Maaz, M. A. Bayoumi, “A Fast and Low Power Multiplier Architecture”, The Center for Advanced Computer Studies, The University of Southwestern Louisiana Lafayette, LA 70504.

[4] Honey Durga Tiwari, Ganzorig Gankhuyag, Chan Mo Kim, Yong Beom Cho,“Multiplier design based on ancient Indian Vedic Mathematics”, 2008 International SoCDesign Conference.

[5] Parth Mehta, Dhanashri Gawali, “Conventional versus Vedic mathematical method forHardware implementation of a multiplier”, 2009 International Conference on Advances in Computing, Control, and Telecommunication Technologies.

[6] Prabir Saha, Arindam Banerjee, Partha Bhattacharyya, Anup Dandapat, “High SpeedASIC Design of Complex Multiplier Using Vedic Mathematics”, Proceeding of the 2011IEEE Students' Technology Symposium 14-16 January, 2011, lIT Kharagpur.

[7] Ramalatha M, Thanushkodi K, Deena Dayalan K, Dharani P, “A Novel Time andEnergy Efficient Cubing Circuit using Vedic Mathematics for Finite Field Arithmetic”, 2009 International Conference on Advances in Recent Technologies in Communication and Computing.

[8] Shamim Akhter, “VHDL Implementation of Fast NxN Multiplier Based on VedicMathematics”, 2007 IEEE.

[9] Anvesh Kumar, Ashish Raman, Dr. R.K. Sarin, Dr. Arun Khosla, Small area Reconfigurable FFT Design by Vedic Mathematics”, 2010 IEEE.

CHAPTER-3.15

Speed Control of Dc Motor Using Adaptive Techniques (MRAC)

Deepak Singh Karki[1], Deepak Kr. Verma[2]
Department of Electrical Engineering, JB Institute of Technology, Dehradun, India
deepak.karki00@gmail.com

ABSTRACT- *Speed control is a common requirement in industrial drives in the presence of varying operating conditions i.e. load disturbance, parameter uncertainties and noise. Conventional controllers with fixed parameters are not successful in real time applications because of the drift in the plants operating conditions. Adaptive control techniques are best suited for these situations. This paper presents a case study on speed control of dc drive using Model Reference Adaptive Control (MRAC). MRAC is one of the main adaptive control schemes. The fluctuation in load is assumed to be an input disturbance on the plant, which causes the deviation in the desired speed. In the literature various adaptive control algorithms have been developed. An adaptive algorithm by Ioannou [8, 9] is applied and simulations have been carried out for different values of load disturbances, parameter uncertainties and output measurement noise. The simulation results reported in this paper demonstrate the effectiveness of the proposed controller against varying operating conditions.*

Keywords –dc drives, MRAC, Adaptive control, Lyapunov approach, tracking control.

INTRODUCTION

A common actuator in control systems is a dc motor and is an obvious choice for implementation of advanced control algorithms in electric drives, due to the stable and linear characteristics associated with it. It is also ideally suited for tracking control applications as shown in references [1, 3, 4, 6,]. From a control system point of view, the dc motor can be considered as a SISO plant eliminating the complexity associated with multi-input drive systems. The speed of a driven load often needs to run at a speed that varies according to the operation it is required to perform. The speed in some cases (such as fluctuating loads like rolling mills) may need to change dynamically to suit the conditions, and in other cases may only change with a change in process. In real time control the parameters are always time variant and are subject to various drifts depending on the operating conditions. It is found that the controllers designed with fixed parameters are not effective in achieving the desired performance and therefore adaptive controllers are best suited. In adaptive control the controller parameters are updated at every instant of time to satisfy the design requirements, unlike the conventional controllers.

This paper describes the rejection of deviation in speed caused by load disturbance for a separately excited dc motor under various load-disturbing situations, parameter uncertainties and measurement noise with an adaptive control approach resulting in an improved performance.

Apart from various conventional control strategies, adaptive control has proved its potential application in tracking/trajectory control problem. Siri Weerasooriya developed a modified adaptive controller based on minimum variance self-tuning controller. This scheme is

effective even in the presence of external disturbances, provided that the system exhibits minimum phase characteristics. El- Sharkawi (1989) developed the variable structure tracking of dc motor for high performance applications. In his work variable structure system control is used for on-line tracking of dc motor. In 1990, Sharkawi developed an adaptive control strategy based on self-tuning control. The purpose of the controller is to force the motor states such as speed, position or armature current to follow prespecified tracks without excessive overshoots and oscillations.

Siri Weerasooriya (1991) used the ability of Artificial Intelligence to identify the system dynamics and for trajectory control, the indirect MRAC is used, which is specifically useful in tracking applications. An attempt has been made to merge the accuracy of MRAC system and calculation speed of ANNs to come up with a trajectory controller for dc motor applications. El-Samahy (2000) [10] described the design of robust adaptive discrete variable structure control scheme for high performance dc drives. Jianguo Zhou (2001) proposed a global speed controller for the separately excited dc motor. In this work the motor is modeled in two local areas, the first model is a linear one when speed is under the base speed and other is nonlinear when speed is to be obtained using field weakening method. For the first part linear robust linear state feedback controller and for nonlinear part adaptive back stepping controller is used. Crnosiya P. (2002) presented In a fuzzy control has been developed with a fuzzy based MRAC for wide range of speed but the sensing of speed due to load change and corresponding determination of fuzzy control parameters in real time is not included. This may be cause of concern in real time applications. the application of MRAC with signal adaptation to permanent magnet brushless dc motor drives. MRAC with signal adaptation algorithm has been applied to compensate parameter sensitivity and influence of load disturbances in this paper MRAC has been tested for load disturbances as well as for parametric variations using adaptive gain control mechanism explained in sections 3, 4 to achieve zero steady state error. Results of simulation are presented along with comparisons to demonstrate the general applicability. The results are very encouraging compared to earlier studies.

MODELING OF DC MOTOR

Control of the motor is achieved by changing the armature voltage as shown in figure 1. The separately excited dc motor drive is characterized in continuous time domain by using the following differential equations.

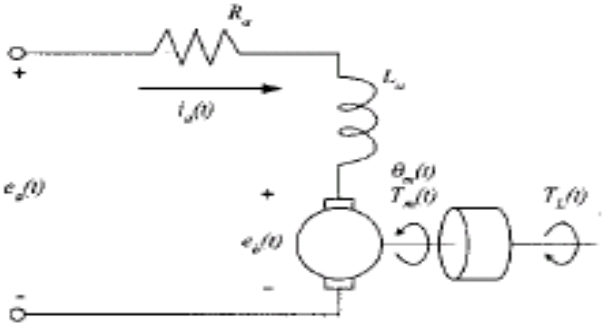


Figure 1 Armature controlled dc motor

THE MAIN ASSUMPTIONS FOR DESCRIBING THE MOTOR DYNAMICS ARE

1. The magnetic circuit is linear (because due to saturation of the magnetic core linear relationship does not hold for high values of field current)

2. The mechanical friction including viscous friction and Coulomb friction is linear in the rated speed region.

In the dc motor model, the variables and parameters are as given below:

R_a =Armature winding resistance [ohms]

L_a =Armature winding inductance [Henry]

i_a = Armature current [amps]

i_f =Field current [amps]=a constant

V_a =Applied armature voltage [volts]

E_b = Back emf [volts]

ω_m = Angular velocity of the motor [rad/sec]

T_m =Torque developed by the motor [Newton-m]

J_m =Moment of inertia of the motor rotor [kg-m^2 or Newton-m/(rad/sec^2]

B_m =Viscous friction coefficient of the motor [Newton-m/(rad/sec)]

T_w =Disturbance load torque [Newton-m]

The input voltage V_a is applied to the armature which has a resistance of Ra and inductance of La. The field current supplied i_f supplied to the field winding is kept constant and thus the armature voltage controls the motor shaft output. The moment of inertia and the coefficient of viscous friction at the motor shaft being J_m and f_m respectively. The speed of the motor is being ω_m radian per second. The related dynamics equations are:

$$V_a = R_a i_a + L_a \frac{di_a}{dt} + E_b \qquad (2.1)$$

$$E_b = K_b.\omega_m \qquad (2.2)$$

$$V_a = R_a i_a + L_a \frac{di_a}{dt} + K_b \omega_m \qquad (2.3)$$

$$T_m = K_T i_a \qquad (2.4)$$

$$T_m = J_m.\frac{d\omega_m}{dt} + B_m.\omega_m \qquad (2.5)$$

Taking the Laplace transform of equation (3.1) - (3.5), assuming zero initial conditions, we get.

$$T_m(s) = K_T I_a(s) \qquad (2.6)$$

$$E_b = K_b \omega(s) \qquad (2.7)$$

$$E_a(s) - E_b(s) = (L_a.s + R_a) I_a(s) \qquad (2.8)$$

$$(J_m.s + B) = T_M(s) - T_L(s) \qquad (2.9)$$

Equation (2.6) - (2.9) gives the transfer function between the motor velocity $\omega_m(s)$ and the input voltage $E_a(s)$ is given as below.

$$\frac{\omega(s)}{E_a(s)} = \frac{K_T}{(L_a s + R_a)(J_m s + B_m) + K_T K_b} \qquad (2.10)$$

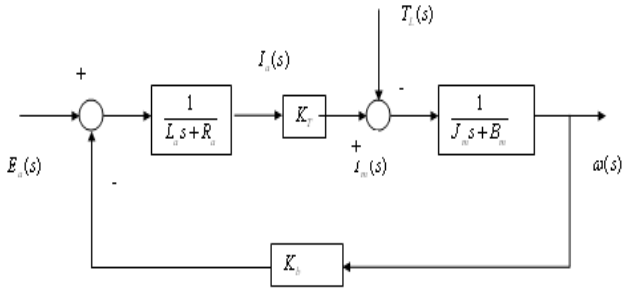


Figure 2 Block diagram of a DC motor (armature controlled) system.

STATE SPACE REPRESENTATION

Let the armature current ($\dot{i}_a = x_1$) and angular velocity ($\omega_m = x_2$) be the state variable and the angular velocity be the output variable. Therefore, the following state space model can represent the dynamics of dc motor.

$$\frac{di_a}{dt} = -\frac{R_a}{L_a}.i_a - \frac{K_b}{L_a}.\omega_m + \frac{V_a}{L_a} \qquad (3.1)$$

$$\frac{d\omega_m}{dt} = \frac{K_T}{J_m}.i_a - \frac{B_m}{J_m}.\omega_m - \frac{T_w}{J_m} \qquad (3.2)$$

$$\dot{X} = Ax + Bu + Fw \qquad (3.3)$$

$$y = Cx \qquad (3.4)$$

where $x = \begin{bmatrix} x_1 & x_2 \end{bmatrix}$; state vector u = Input to the motor (scalar) T_w = Load disturbance, N_m

Matrix A, B and F are given as:

$$A = \begin{bmatrix} -\frac{B_m}{J_m} & \frac{K_T}{J_m} \\ -\frac{K_b}{L_a} & -\frac{R_a}{L_a} \end{bmatrix}; B = \begin{bmatrix} 0 \\ \frac{1}{L_a} \end{bmatrix}; F = \begin{bmatrix} -\frac{1}{J_m} \\ 0 \end{bmatrix}$$

$$C = \begin{bmatrix} 1 & 0 \end{bmatrix}$$

For the design of MRAC controller the triple (A, B, C) is assumed to be completely controllable and observable. The load changes are considered as changes in motor rotor inertia and viscous-friction coefficient as practically seen in most control applications. Hence plant parameter changes in the simulation studies reflect abrupt load changes of the system.

MODEL REFERENCE ADAPTIVE CONTROL

The objective of model reference control is to ensure the output of a controlled system (plant) to track the output of a chosen reference model, in addition to closed-loop stability [1, 7, 8]. When the plant parameters are unknown, adaptive laws are designed to update the parameters of a controller to provide the desired output. In this scheme, the objectives of control are specified by the output of the reference model. The design problem involves the adaptation of controller parameters based on past values of controller parameters and the control inputs such that the error between the plant and model outputs approaches zero asymptotically. The tracking error represents the deviation of the plant output from the desired trajectory. The closed-loop plant consists of output feedback, controller (with adjustable parameters) and an adjustment mechanism that adapts the controller parameters online. The main issues are controller parameterization, error model derivation, minimum priori plant knowledge, adaptive law design, and stability analysis [15]. The basic structure of this MRAC scheme is shown in figure 3.

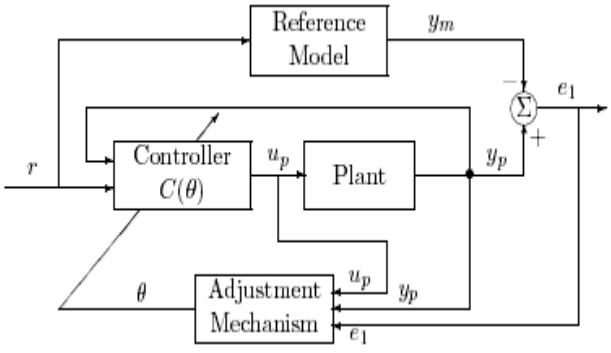


Figure 3: Basic structure of MRAC scheme

DIRECT AND INDIRECT MRAC

An adaptive controller is formed by combining a parameter estimator, which provides estimates of unknown parameters at each instant, with a control law that is motivated from the known parameter case. The way the parameter estimator (adaptive law) is combined with the control law give rise to two different approaches. In the first approach, referred to as indirect adaptive control, the plant parameters are estimated on-line and used to calculate the controller parameters. In the second approach, referred to as direct adaptive control, the plant model is parameterized in terms of the controller parameters that are estimated directly without intermediate calculations involving plant parameter estimates.

The main differences between indirect and direct adaptive control lies in the following two facts:

- A model of the desired behavior is explicitly used in direct control whereas a model of the plant identified on-line is used in indirect control.
- Identification error in indirect control and the control error in direct control are used to update the controller parameters.

DESIGN BASED ON LYAPUNOV APPROACH

Stability is an extremely important factor, which must be taken into consideration in the design of MRAC systems because these systems behave like non-linear, time-varying systems. In earlier designs (MRAC)based on MIT rule) instability may arise because of faster adaptations and also for large inputs. Hence, to achieve acceptable design, stability aspect should be incorporated by using the Lyapunov approach. This method of developing adaptive laws is based on the direct method of Lyapunov and its relationship with positive real functions. In this approach, the problem of designing adaptive law is formulated as a stability problem where the dynamical equation of the adaptive law is chosen such that certain stability conditions based on Lyapunov theory were satisfied. In this approach, the first step is to obtain differential equation that describes the error between the output of the reference model and that of plant. The objective is parameter updation for controller equations, which also assures that the differential equation, which describes the error gradually leads to asymptotic stability. To achieve this, a positive-definite Lyapunov function is formulated for the error equation. The adaptation mechanism is then selected so as to ensure the time derivative of the Lyapunov function to be negative definite and results in globally asymptotically stable closed-loop system. Next section describes the design method with the above objective.

DESIGN OF MRAC FOR LTI SISO SYSTEM PLANT MODEL: Consider an unknown, single input, single output, and linear time-invariant plant in the form of $G_p(s) = k_p \dfrac{Z_p(s)}{R_p(s)}$

(5.1) or in the equivalent state space form as

$$\dot{x}_p = A_p x_p + B_p u_p, x_p(0) = x_0$$
$$y_p = C_p{}^T x_p$$

(5.2) where $x_p \in R^n; y_p, u_p \in R^1$ *and* A_p, B_p, C_p *have the appropriate dimensions.* Z_p, R_p *are the monic polynomials and* k_p *is a constant referred to as the High Frequency Gain (HFG). In order to meet the MRAC objective plant model satisfy the following assumptions.*

P1. $Z_p(s)$ is a monic Hurwitz polynomial of degree m_p.

P2. An upper bound n of the degree n_p of $R_p(s)$.

P3. The relative degree $n^* = n_p - m_p$ of $G_p(s)$, and

P4. The sign of the high frequency gain k_p is known.

REFERENCE MODEL

The objective of the control system is to find a direct controller that is differentiator free, and the output of the plant should follow the output of the pre-specified reference model. The model is chosen in the form of

$$W_m(s) = k_m \frac{Z_m(s)}{R_m(s)} \qquad (5.3)$$ where $Z_m(s), R_m(s)$ are monic polynomials and k_m is constant gain and r is the reference input assumed to be a uniformly bounded and piecewise continuous function of time. The following assumptions regarding reference model are assumed to hold:

M1. $Z_m(s)$, $R_m(s)$ are monic Hurwitz polynomials of degree q_m, p_m respectively, where $p_m <= n$.

M2. The relative degree $n_m^* = p_m - q_m$ of $W_m(s)$ is same as that of $G_p(s)$, i.e., $n_m^* = n^*$.

STATEMENT OF THE PROBLEM

The problem statement can be stated as follows:

Given input and output from dc motor as in (5.1) and a reference model described by (5.3), the control input u(t) to the plant is be determined such that:

$$\lim_{t\to\infty} |e(t)| = \lim_{t\to\infty} | y_p(t) - y_m(t) | = 0 \qquad (5.4)$$ In the plant considered the occurrence of load on the motor causes disturbance. Due to this load disturbance the speed of the motor fluctuates, so the designed scheme must be able to reject the variation in motor speed and reach the steady desired speed within time by reference model.

CONTROLLER STRUCTURE: To meet the above specifications, the controller structure is organized as:

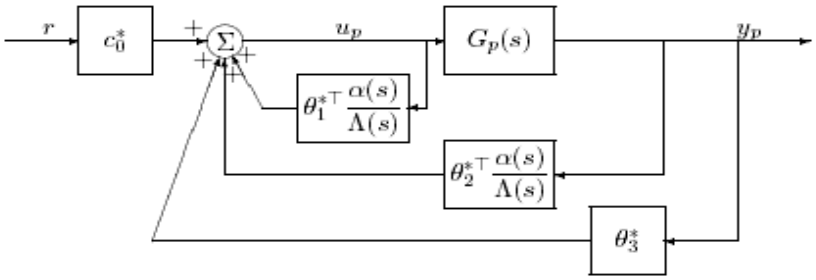


Figure 4: Controller structure

$$u(t) = \theta_1^T(t)\frac{\alpha(s)}{\Lambda(s)}u + \theta_2^T(t)\frac{\alpha(s)}{\Lambda(s)}y_p + \theta_0(t)y_p + c_0 r \qquad (5.5)$$

$$\theta^*(t) = [\theta^{*T}_1(t), \theta^{*T}_2(t), \theta^*_0(t), c_0^*]^T$$

where $\alpha(s) = [s^{n-2}, s^{n-3}, ..., s, 1]^T$; for n>=2 $\alpha(s) = 0$

; for n=1

where $\Lambda(s)$ is an arbitrary monic Hurwitz polynomial of degree n-1 that contains $Z_m(s)$ as a factor, i.e.,

$$\Lambda(s) = \Lambda_0(s)Z_m(s) \qquad (5.6)$$

which implies that $\Lambda_0(s)$ is monic, Hurwitz and of degree n_0=n-1-q_m.The controller parameter vector is chosen such that the transfer function from r to y_p equals to $W_m(s)$.The I/O properties of the closed loop plant are described by the transfer equation

$$y_p = G_c(s).r \qquad (5.7)$$

we can now meet the control objective if we select the controller parameters, so that the closed loop poles are stable and the closed loop transfer function $G_c(s) = W_m(s)$ is satisfied.

DESIGN OF MRAC FOR RELATIVE DEGREE N=2

The main characteristics of the standard MRAC scheme developed are:

(i) The adaptive laws are driven by the estimation error, which due to the special form of the control law is equal to the tracking error. They are derived using the SPR-Lyapunov approach.

(ii) A Lyapunov function is used to design the adaptive law and establish boundedness for all signals in the closed loop plants. The design of MRAC to meet the control objective control law (5.5) can be written in state space form.

$$\begin{aligned}
&\dot{\omega}_1 = F\omega_1 + gu_p, \omega_1(0) = 0 \\
&\dot{\omega}_2 = F\omega_2 + gy_p, \omega_2(0) = 0 \\
&u_p = \theta^{*T}\omega
\end{aligned} \tag{6.1}$$

$$\omega = \begin{bmatrix} \omega_1^T & \omega_2^T & y_p & r \end{bmatrix}^T, \omega_1, \omega_2 \in R^{n-1}$$

Where $\theta(t)$ is the estimate of θ^* at time t to be generated by an approximate adaptive law. Obtaining the composite state space representation of the plant and the controller i.e.

$$\begin{aligned}
&\dot{Y}_c = A_c Y_c + B_c c^*_0 r, Y_c(0) = Y_0 \\
&y_p = C_c^T Y_c
\end{aligned} \tag{6.2}$$

Where $Y_c = [x_p^T, \omega_1^T, \omega_2^T]^T$

$$A_c = \begin{bmatrix} A_p + B_p\theta_3^* C_p^T & B_p\theta_1^{*T} & B_p\theta_2^{*T} \\ g\theta_3^* C_p^T & F + g\theta_1^{*T} & g\theta_2^{*T} \\ gC_p^T & 0 & F \end{bmatrix}, B_c = \begin{bmatrix} B_p \\ g \\ 0 \end{bmatrix}$$

$$C_c^T = \begin{bmatrix} C_p^T & 0 & 0 \end{bmatrix}$$

and Y_0 is the vector with initial conditions. Then adding and subtracting the desired input $B_c\theta^{*T}\omega$ to obtain

$$\dot{Y}_c = A_0 Y_c + B_c\theta^{*T}\omega + B_c(u_p - \theta^{*T}\omega) \tag{6.3}$$

Rewriting the above equation

$$\begin{aligned}
&\dot{Y}_c = A_c Y_c + B_c c_0^* r + B_c(u_p - \theta^{*T}\omega), Y_c(0) = X_0 \\
&y_p = C_c^T Y_c
\end{aligned} \tag{6.4}$$

Defining $e = Y_c - Y_m$ and $e_1 = y_p - y_m$ where Y_m is the state of the nonminimal representation of the reference model. Error equation is given by:

$$\begin{aligned}
&\dot{e} = A_c e + B_c(u_p - \theta^{*T}\omega), e(0) = e_0 \\
&e_1 = C_c^T e
\end{aligned} \tag{6.5}$$

The above equation is rewritten as

$$e_1 = W_m(s)\rho^*(u - \theta^{*T}\omega) \tag{6.6}$$

Where $\rho^* = \dfrac{1}{c_0^*}$.

Substituting the control law in equation (6.5), the resultant error equation is given by

$$\dot{e} = A_c e + \bar{B}_c \rho^* \tilde{\theta}^T \omega, e(0) = e_0$$
$$e_1 = C_c^T e \qquad (6.7)$$

Where $\bar{B}_c = B_c c_0^*$ or $e_1 = W_m(s)\rho^* \tilde{\theta}^T \omega$, which relates the parameter error $\tilde{\theta} = \theta(t) - \theta^*$ with the tracking error. Because $W_m(s) = C_c^T (sI - A_c)^{-1} B_c c_0^*$ is SPR and A_c is stable, equation (6.7) is in appropriate form for applying the SPR-Lyapunov approach. With $n^*=2$, $W_m(s)$ is no longer SPR and therefore by using the identity $(s+p_0)(s+p_0)^{-1} = 1$ for some $p_0>0$, rewriting the above equations

$$\dot{e} = A_c e + \bar{B}_c (s+p_0)\rho^* (u_f - \theta^{*T}\phi), e(0) = e_0$$
$$e_1 = C_c^T e \qquad (6.8)$$

i.e.,

$$e_1 = W_m(s)(s+p_0)\rho^*(u_f - \theta^{*T}\phi) \qquad (6.9)$$

where $\bar{B}_c = B_c c_0^*$

$$u_f = \frac{1}{(s+p_0)} u, \phi = \frac{1}{(s+p_0)} \omega \qquad (6.10)$$

and $W_m(s)$, $p_0>0$ are chosen such that $W_m(s)(s+p_0)$ is SPR.

Choosing $u_f = \theta^T \omega$ and rewriting the error equation

$$\dot{e} = A_c e + \bar{B}_c (s+p_0)\rho^* \tilde{\theta}^T \phi, e(0) = e_0$$
$$e_1 = C_c^T e \qquad (6.11)$$

or, in the transfer function form

$$e_1 = W_m(s)(s+p_0)\rho^* \tilde{\theta}^T \phi \qquad (6.12)$$

Transforming the above equation by using the transformation

$$\bar{e} = e - \bar{B}_c \rho^* \tilde{\theta}^T \phi$$

i.e.

$$\dot{\bar{e}} = A_c \bar{e} + B_1 \rho^* \tilde{\theta}^T \phi, \bar{e}(0) = \bar{e}_0$$
$$e_1 = C_c^T \bar{e} \qquad (6.13)$$

where $B_1 = A_c \bar{B}_c + \bar{B}_c p_0$ and $C_c^T \bar{B}_c = C_p^T B_p c_0^* = 0$ due to $n^*=2$. With the above error equation adaptive law can be designed as:

$$u = (s+p_0)u_f = (s+p_0)\theta^T \phi \qquad (6.14)$$

which implies

$$u = \theta^T \omega + \dot{\theta}^T \phi \qquad (6.15)$$

$\dot{\theta}$ is available from the adaptive law, the control law given by the above equation can be implemented without the use of differentiators.

Considering the Lyapunov like function as in the previous case for generating adaptive law

$$V(\tilde{\theta}, \bar{e}) = \frac{\bar{e}^T P_c \bar{e}}{2} + \frac{\tilde{\theta}^T \Gamma^{-1} \tilde{\theta}}{2} \left| \rho^* \right| \qquad (6.16)$$

where $P_c = P_c > 0$ satisfies the MKY Lemma.

$$\dot{\theta} = -\Gamma e_1 \phi \operatorname{sgn}(k_p / k_m) \qquad (6.17)$$

The signal vector ϕ is expressed as

$$\phi = \frac{1}{s + p_0} \begin{bmatrix} (sI - F)^{-1}.g.u_p \\ (sI - F)^{-1}.g.y_p \\ y_p \\ r \end{bmatrix} \qquad (6.18)$$

which implies that $\bar{e}, \tilde{\theta}, e_1 \in L_\infty$ and $\bar{e}, e_1 \in L_2$.

SELECTION OF REFERENCE MODEL

The first step in controller design is to select a suitable reference model for the motor to follow. Let us assume that the dc motor is to behave as a second order system whose input is $r(t)$ and the output is $\omega_m(t)$. For a continuous- time system, the reference model can be selected as the ideal second order system transfer function.

$$\frac{\omega_m(s)}{R(s)} = \frac{\omega_n^2}{s^2 + 2\xi\omega_n s + \omega_n^2}$$

In this case, the speed desired is 57.6 rad/s (550rpm). The damping coefficient (ξ) is taken as one in order to represent critical damping. The above design procedure ensures that the reference model is compatible with the actual motor dynamics. This is an important consideration since an arbitrarily selected reference model can degrade the tracking performance. In case of large and abrupt reference tracks, a bound on the control signal is needed or the control technique must be modified to include the control signal in the performance index. The desired trajectory is as given in figure 5.For the system considered under case study desired specification are given in the following table.

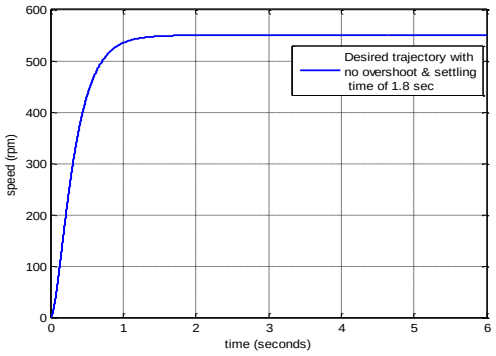


Figure 5. Desired trajectory described by reference model.

Simulation Results: A separately excited dc motor with nameplate ratings of 1 hp, 220 V, 550 rpm is used in all simulations. The following parameter values are associated with it. [6]

J_m=0.068 kg-m^2 or Nm/(rad/sec^2).

B_m=0.03475 Nm-sec or Nm/ (rad/sec).

R_a=7.56 ohms.

L_a=0.055 Henry.

K_T=3.475Nm-$A^{-1.}$

K_b=3.475 V/rad/sec.

In this work the adaptive control scheme (MRAC) is simulated for various loading conditions, parameter uncertainties and measurement noise. The performance of the dc motor is studied from no load to full load and open loop to adaptive closed loop. To test the system performance the data of the dc motor is taken from [6]. In the design maximum control input limit is kept 250 volts and the maximum motor current is 1.5 times of full load current. The adaptation gain of 0.0008 is selected after a number of trials, which suits the rating of the dc motor.

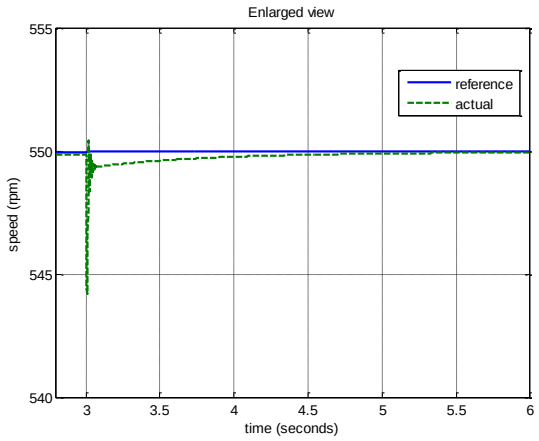


Figure 6. Tracking performance at full load (12.95 Nm) applied at t=3 sec.

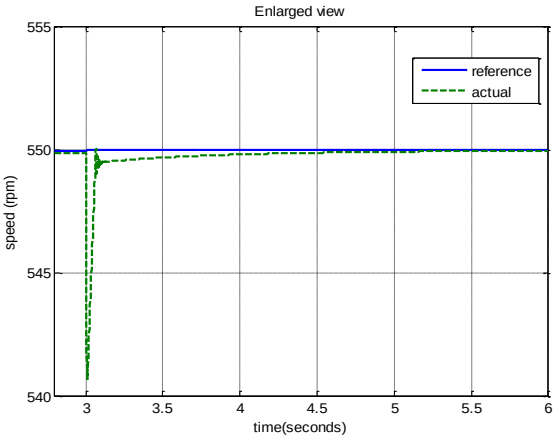


Figure 7. Tracking performance at 125% of full load applied at t=3 sec.

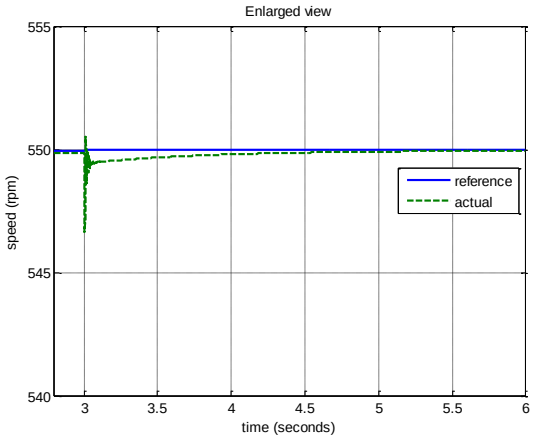


Figure 8. Tracking performance at 75% of full load applied at t=3 sec.

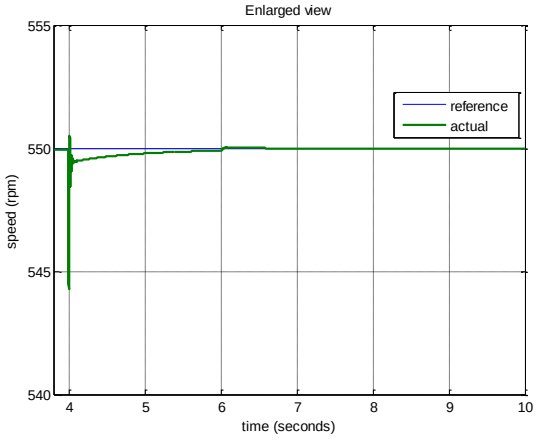


Figure 9. Full load applied at t=4 sec and thrown off at t=6sec

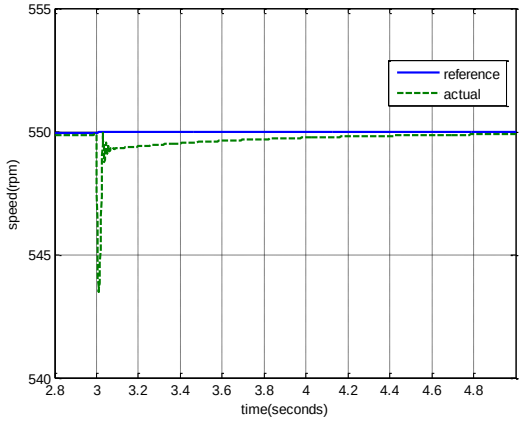


Figure 10. Speed tracking after parameter variation of +20% from nominal value

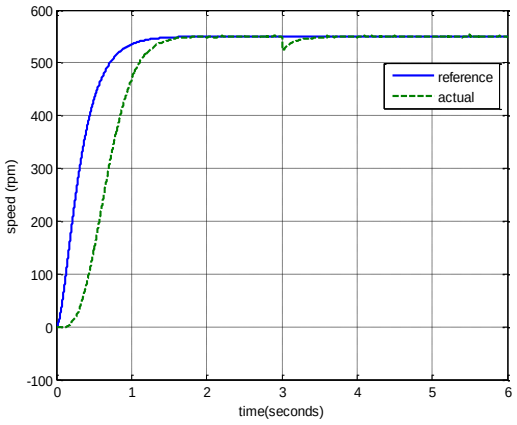


Figure 11. Tracking Responses under measurement noise (±0.1 rad/sec)

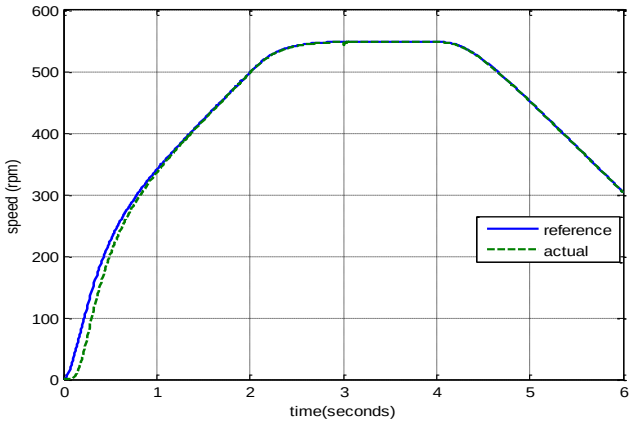


Figure 12. Tracking Responses for trapezoidal trajectory when load is applied at t=3sec.

DISCUSSIONS AND CONCLUSION

From the simulation results it is inferred that for the limiting value of the control input, the value of adaptation gain can be varied up to certain maximum value. If it is further increased controller parameter does not converge to some constant value. Although as the adaptation gain is increased (within that max value) the adaptation becomes faster on account of

becoming control input violently high this may not be compatible to the system. It is also inferred that with the increase in adaptation gain the error becomes smaller. All the results are found for the adaptation gain of 0.0008. All the results show the values of control input (armature voltage), input current (armature current) and speed as per the motor ratings (plots are not shown due to space constraints). To demonstrate the effectiveness of the MRAC, the system (dc motor) has been simulated under various operating conditions such as load disturbance, parameter uncertainties, and measurement noise and for different shapes of tracks selected. Robustness is of particular importance in most of the control applications. Controllers with the fixed parameters cannot be robust unless unrealistically high gains are used. Hence the fixed controller parameter controllers cannot be considered for high performance applications. Simulation result shows that the robustness is greatly enhanced by this adaptive scheme, by continually adjusting the controller parameters to counteract the change in system operating conditions. The adaptive scheme used for the dc motor also demonstrates the load disturbance rejection capability. So, this capability is important when a motor is to be operated at constant speed under varying load perturbations. The oscillatory nature in the control input is due to external load disturbances. Simulation study shows some initial oscillations in the control signal are evident because the initial values of controller parameters are obtained by the off-line estimation, which may not be accurate enough. However, once on-line updation begins the controller parameters are more accurate and the control signal is much smoother. In order to get the smoother control signal, controller parameter estimation can be started from some intermediate values by providing initial values of the controller parameters. The initial parameters can be chosen on the basis of simulations carried out for particular operating conditions. It results to the faster adaptation of the reference trajectory. A dc motor has been successfully controlled using MRAC. The unknown, time variant nonlinear load characteristics have been successfully captured by this adaptive scheme. Particularly the robustness of the controller is of importance because noisy operating conditions are very common in practical applications.

REFERENCES

[1] Dressler M. Robert, “An approach to Model Reference adaptive control systems,” IEEE Transactions on Automatic Control, vol.12, No.1, pp.75-79, 1967.
[2] El-Sharakawi and Huang, “Variable structure tracking of dc motor for high performance applications,”IEEE Transactions on Energy Conversions,”Vol.4, No.4, December 1989.
[3] Siri Weerasooriya & M.A. EI-Sharkawi, “Adaptive Tracking Control High Performance DC Drives”IEEE Transactions on Energy Conversion, Vol.4, No.3, September 1989.
[4] M.A. EI-Sharkawi & Siri Weerasooriya, “Development and Implementation of Self-Tuning Controller for DC Motor” IEEE Transactions on Energy Conversion, Vol.5, No.1, March 1990.
[5] Jiangno Zhou and Wang, “Global speed control of separately excited dc motor,”IEEE proceedings, 0-7803-6672-7/01/2001.
[6] Siri weerasooriya &Sharkawi,” Identification and control of a DC motor using BP neural networks”, IEEE transactions on Energy conversion, DEC, 1991
[7] Siri Weerasooriya & M.A. EI-Sharkawi, “Laboratory Implementation of a Neural Network Trajectory Controller for a DC Motor”IEEE Transactions on Energy Conversion, Vol.8, No.1, March 1993.
[8] Karl J. Astrom, Bjorn Wittenmark, Adaptive control, II edition, Pearson Education, 1995.

INTEGRATED SOLUTIONS: MECHANICAL ENGINEERING

CHAPTER-4.1

Planning Issues of Supply Chain Management

Dr. P. K. Chaudhary[1], Dr. Bharat VPS Rawat[2]
[1]Professor, JB Institute of Technology, Dehradun, Uttrakhand, India
[2]Associate Professor, JB Institute of Technology, Dehradun, Uttrakhand, India

ABSTRACT: *Supply chain is the buzz word of today's business environment. Planning is an important aspect for the success of supply chain management. Further, poor planning always leads to faulty supply chain management. With this as viewpoint authors have endeavored to put forward the issues pertaining to the supply chain planning. In this paper, the planning issues of supply chain management are viewed from the perspective's Individual issues. The authors have considered all the issues of real business situations which managers are generally considers for planning the supply chain.*

Key words: Supply Chain Management, Decision making.

INTRODUCTION

Supply chain management mainly deals with planning issues. Poor planning always yields a situation of unsold quantities, excessive inventory, rise in cost, delay in delivery, etc. The following decision problems are generally addressed in supply chain planning.

1. Deciding marketing objective.
2. Deciding the number of production and distribution centers, and their locations.
3. Deciding the number of suppliers, so-called partners, which should be chosen from a particular location.
4. Deciding the capacity of the partners.
5. Deciding what routes or modes are to be followed for delivery.
6. Deciding the order quantity to the suppliers.
7. Deciding the distribution quantity.
8. Deciding the batch size for delivery.
9. Deciding the sequence in which the production should take place.

In supply chain planning, these managerial questions are frequently dealt by the decision maker. They also encounter challenge in achieving the best planning for a supply chain to respond to various possible hurdles that may occur in future and also to best optimize and utilize the available resources. The objective of the supply chain planning is to increase the profit of all the partners in the whole chain. Planning on the basis of time horizon may be categorized as: (1) long term planning, (2) medium term planning, and (3) short term planning. The time horizon for long term planning is of 2 to 5 years approximately. For medium term and short term planning, the time horizon ranges from 1 to 2 years and 1 week

to 1 year respectively (Gupta and Maranas, 2003). Another distinction in supply chain planning is attributed to the criticality of decisions involved into the planning and involvement of the hierarchy of the management in the decision making process. With this view point, a supply chain planning may be distinguished as: (1) strategic planning, (2) tactical planning, and (3) operational planning. The top management is involved into strategic planning which is long term in nature. Middle and lower management respectively deal with tactical (medium term) and operational (short term) planning. In order to meet customer demand with "guaranteed delivery" of "high quality" and "low cost" of products with "minimal lead time", companies need to have better visibility into the entire supply chain to look different options in cost cutting programme. The key planning issues linked to this aspect of supply chain management are discussed in next section-

PLANNING ISSUES

Planning is the key to success and the supply chain management too. In order to plan a supply chain we always look forward that issues related to it must be resolved. Considering this as view point, the planning issues pertaining to a supply chain management is elaborated in this section.

Network planning: A supply chain (SC) network is described by its basic elements, e.g. (1) structure, (2) dynamics or pattern of flow (Taylor, 2004) and (3) types of partnership. This refers to the planning for the skeleton of supply chain. This is prerequisite for the supply chain planning. Broadly speaking, planning of the structure includes decision making for (1) number of echelons and (2) number of members at each echelon. In other words, this activity comprises of the development of stage and/or facilities at every stage depending upon the economy and dynamics of flow of materials, money and information. With the increase in the number of echelons, the length (horizontal dimension) of the supply chain increases; whereas, increase in the number of members at one or more echelons leads to the increment in height (vertical dimension). Thus, it may be said that number of echelons and number of members at each echelon, in turn, would govern the horizontal and vertical dimensions of the supply chain. The network plan starts with the chaining of organizational units, i.e. by linking those organizations which best fit the existing supply chains according to the requirement of the service level as prescribed by the customers and end users. Obviously, global aspects will play an important role while deciding the capabilities (e.g. product and process knowhow as well as the financial position) of potential partners. Partnership is not created in conventional sense, rather it is continuously developed over product life cycle (Stadtler, 2005). The fitness of a member of a chain is tested in the form of due attentiveness and trustworthiness. The cooperation amongst the partners should be such that all the members of SC get benefited. Thus, the strategy should be of win–win type. From a financial perspective, cooperation may also be achieved by adopting transfer price negotiation scheme within the chain. According to this scheme, a partner has to be paid compensation, if asked to give up locally optimal decisions in favour of the chain as a whole.

Another aspect of network planning is to control the members of the network. The challenge, in controlling such a network, stems from the nature of relationships between SC partners. The type of relationship is based on two facts: (1) degree of integration, and (2) independence of ownership (Taylor, 2004). In a supply chain, the partners are neither the part of a single hierarchy nor loosely coupled merely by adhoc trading relations. Therefore, one must seek a control point between these two extremes. Generally, collaborative relationship is argued for the strategic suppliers. Therefore, a control point may be set even in the case of adhoc relationship when only some non critical items are to be purchased and frequency of the purchase is very less. The control point is also set towards vertical integration (i.e. strategic partnership) if more chance is there for losing business associated with the items supplied by those partners.

The objective of the network planning is to mitigate the complexity arising in the primary 'flow' of materials. A sound network planning not only reduces the complexity of the flow, but also helps in reduction of the situation of chaos among the members of the said chain. Since network planning is closely linked with the other planning issues, it may be regarded as a key planning area. This type of planning involves decision making for number of partners at each echelon, identification of nature of collaboration with the partners, and many more. At the strategic level, it considers deciding the configuration of the network (i.e., number, location and capacity), and technology of the production and distribution facilities. The configuration decisions mainly consist of deciding which of the processing centers to build (major configuration decisions) and which processing and finishing machines to procure (minor configuration decisions). At tactical level, it involves deciding the aggregate quantities and material flows for purchasing, processing and distribution of products. The strategic configuration of the supply chain is a key factor influencing efficient tactical operations and, therefore, has a long lasting impact on the firm. Furthermore, the fact that the supply chain configuration involves the commitment of substantial capital resources over long periods of time, it makes the supply chain network design problem extremely important (Santoso*et al.*, 2005). Once decision has been taken on number of members and their interrelationship, the next important decision is to plan for supply.

Supply planning: For a typical manufacturer, purchased items (such as raw materials) may represent 70% of its total sales (Amid *et al.,* 2011). Therefore, it is essential to carefully manage the supply process. The effectiveness of the supply process ultimately depends upon the order quantity allocation strategy adopted by a firm for their suppliers. This process, in turn, helps in establishing a competitive and effective purchasing function (Mafakheri*et al.*, 2011). In this regard, the most important challenge faced by a supply chain manager is to plan for the supply in commensuration to the requirements. This problem mostly deals with the selection of right number of suppliers for supplying raw materials, parts and components required by the firm. Selection is generally based on multiple criteria like quality, cost, reliability, etc (Bharadwaj, 2004). The selection criteria ultimately are decided by the top management and depend upon the requirement of the buyer organization (Amid *et al.,* 2011,

Yücel and Güneri, 2011). This issue is of much greater importance as the companies can exercise their discretion in opting for right group of suppliers/vendors for receiving selected items as raw materials from them in right quantities. It is needless to mention that the size of the order would ultimately depend upon the customer's order policy. Basically, there are two kinds of supplier selection problems described as follows.

Supplier selection problem with no constraints: Here, all the suppliers can satisfy the buyer's requirements of demand, quality, delivery, etc (Amin *et al.*, 2011).

Supplier selection problem with limitations on supplier's capacity, quality, etc: In other words, a single supplier cannot satisfy the buyer's total requirements in this situation. Thus, the buyer has to fulfil its needs to be met by a supplier partly and remaining part from other suppliers to compensate for the shortage of capacity or low quality of the first supplier (Wu *et al.* 2010; Mendoza and Ventura, 2010).

In the first kind of supplier selection, there is definitely a supplier (*single sourcing*) who can meet all the buyer's needs. The management has to just identify the best supplier. Whereas in the second case, more than one supplier (*multiple sourcing*) are to be selected (Aissaoui, *et al.*, 2007) as no supplier can satisfy all the buyers' requirements.

Both the single and multiple sourcing strategies have their own merits and demerits. Naturally, in single sourcing strategy, there may be better collaboration and partnership as a result of which joint planning may not have any ambiguity. In contrast to the single sourcing strategy, multiple sourcing strategy may result into high level of robustness and reliability (Awasthi*et al.*, 2009). Moreover, when consolidating and reducing the number of suppliers, sometimes companies may run at the risk of not having sufficient raw materials to meet their fluctuating demand. Such risks may be caused by natural disasters or man-made actions. As a result, there is a need to tradeoff between the benefits of managing with few selected suppliers and the risk with the supplies (Li and Zabinsky, 2011). In this situation, a manager has to decide

1. the quantity of a product to be purchased from suppliers,
2. the supplier, out of already selected pool of suppliers, to which the product will ordered, and
3. the period in which a particular supplier will fetch materials for a particular product (Basnet and Leung, 2005, Rezaei and Davoodi, 2008).

Whether this order quantity will be acceptable to the suppliers or not, this itself is a big issue.

In many cases, where a product or raw material is needed for a short duration, a long term commitment with suppliers is not desirable. In this situation, either due to the absence of long term commitment (consistent demand) or probably due to technical constraints, the suppliers may not be ready to invest in augmenting their capacity (Awasthi*et al.*, 2009). In order to have a high reliability of suppliers and assurance that the supplier will accept the order quantities, one has to go for a long term commitment with the suppliers. For long term

commitment, appropriate suppliers must be selected. Selecting an appropriate supplier can significantly help in reduction in purchasing costs, decrease in production lead time, increase in customer satisfaction, and strengthening of corporate competitiveness (Li and Zabinsky, 2011). In addition, manufacturing firms must make a timely estimate of materials or components available from each selected supplier in order to minimize purchasing costs, and should also work on means for long term relationship that can be devised.

Inventory planning / control: Wadhwa and Ravindran (2007) reported that inventory occupies 20% to 60% of the total assets of a manufacturing firm. Inventory is the necessary evil in the sense that if it is in hand, a cost is incurred on its holding for a period, but is generally held in hand to substantiate the surge in demand over the planning horizon. In this way, it works as a double edged sword. Therefore, management bothers too much for its planning. The inventory planning involves acquiring and maintaining a proper merchandise assortment while compromising with related costs, e.g. ordering/transaction cost, shipping cost, etc. It also requires a systematic process to identify inventory requirements, replenishment techniques, a system for reporting actual and projected inventory status, and a system of tracking and management of materials. This would also include the process for monitoring of material moved into and out from stockroom and the reconciling of the inventory balances. For a supply chain dealing with physical distribution of goods, primary objective of the inventory planning is to control stock levels. Inventory control has to describe the way primarily for designing and managing the storage policies.

Inventory planning and control generally deals with the issues like‘‘How much to order’’, ‘‘when to order’’, ‘‘how much to stock’’, ‘‘how much shortage to be permitted’’ and so on. These are the fundamental issues with which the managers commonly deal and try to resolve. These decisions are often subjected to several constraints such as budget, storage space requirements for the goods that can be stored, etc. The decision making becomes strenuous while dealing with multiple products (Haksever and Moussourakis, 2005, Haksever and Moussourakis, 2008, Chopra *et al.*, 2011).

Production planning: Production is one of the important activities with which SCM deals. More specifically, production planning describes the design and management of the entire manufacturing activities, e.g. scheduling of raw material purchase, manufacturing process sequencing, line balancing etc. Effective production planning is essential and is foundation of the supply chain as all purchasing schedules are affected by the production schedule and vice versa. The production planning is constrained by the situations changing on daily or hourly basis, customer emergencies, rush orders, machine breakdowns, quality problems etc. Since this list is endless, there is a requirement of a robust plan to accommodate all such variations that influence the production cost as well as materials requirement. Production planning also includes decision making on production volume and amount of inventory to be kept as stock.

In general, a production plan is made to determine the quantity to be produced in specific periods of a given planning horizon in commensuration with the demand in these periods.

Usually, production planning is done at aggregate level, for both produced units and the resources required for them.

Production planning represents the heart of any supply chain planning as it helps in conversion of raw materials into finished product by utilizing related resources effectively and efficiently. During the production at a plant, often the presence of defective items can be observed in the lot of produced items. When the defective item reaches the customer, it may either be returned to the manufacturer or sold at a reduced price. The defective items may also be rejected, repaired or reworked depending upon the economics and technicality associated with its repairing or reworking. Minor defects may be reworked even at the consumers point. In some cases, items of imperfect quality, not necessarily defective, could also be used for another purpose (Rezaei and Davoodi, 2008). For reworking, 100% inspection (screening) must be performed in order to identify the amount of good quality items, imperfect quality items and defective items in a lot. Additionally, reworking of rejected items can also be accounted in planning the production quantity (Chan *et al.*, 2003). Furthermore, proper sequencing of the multiple products, with different setup and processing times, may help in reduction of the total waiting time. This in turn will help in reduction of the total holding cost at a plant and rescheduling of the supplies. Allahverdi*et al.* (2008) have made an exhaustive review on production sequencing. After production, the next activity is the distribution of the produced quantity to the consumers.

Distribution/Logistics planning: The characteristics of today's competitive environment, such as the speed of distribution with high efficiency and low operational costs, are forcing companies to continuously search for ways to improve their operations by proper distribution/ transportation planning. This planning commonly involves both the design of the logistics network and the management of materials flow within the network. The network considers raw materials suppliers, manufacturing plants, distribution channels, warehousing locations and customers' geographical dispersion.

Distribution planning problem includes the designing of a distribution network, i.e. determination of how much of a product type is to be flown from one location to other using the network. In physical distribution system, use of retailers provides a company with flexibility to respond to changes in the marketplace. Thus, the distribution planning problems are mostly encountered in delivering products from warehouses to retailers and/or from plants to warehouses. Normally, this decision is influenced by the capacity of vehicles, number of vehicles available for the distribution, associated cost, and condition of full truck load or part truck load shipments (Chen, 2004). Transportation costs may include fixed and variable costs.

Traditionally, manufacturers managed distribution operations internally. As the complexity of supply chain increased and the market became increasingly competitive, many manufacturers realized that distribution operations are not their core competence and these operations may be outsourced. Thus, they started relying on professional distributors, an external entity. With this change in environment, professional distributors emerged to

manage, control and deliver products to the customers on behalf of the manufacturers (Hertz and Alfredsson, 2003; Jung *et al.*, 2008). Recently, some professional distributors extended their service portfolio to more advanced and complex services such as planning and coordination of supply chain. Also, the direct access to the customers endows the distributors with opportunities to constantly extend their control from only distribution task to the coordination of the whole supply chain (Jung *et al.*, 2008).

Location planning: Facility location planning is a common supply chain planning problem for allocating facilities at the places such that the total cost of transportation from these places to the different marketplaces is the minimum. Location planning is generally strategic in nature. Once a location for a facility is fixed, a great amount of loss would be involved for its relocation as establishment cost will always come into the picture for fixing the facility at the new location.

The establishment cost is generally very high compared to all other costs. Choice of location for establishment of facilities in a supply chain provides an optimal platform for efficient and effective supply chain management.

A typical location problem involves choosing "p" locations among "n" potential locations ($p \leq n$) for establishment of facilities and allocating demand to these locations with an objective to minimize the total weighted distance (or cost) between the facilities and the demand locations. The classical warehouse location problem is an example of a location problem. In this problem, the number and location of warehouses are to be determined in addition to assigning demand at a minimum cost without violating the capacity restriction of these warehouses.

A cost benefit analysis is worked out between the total cost required in installation of facility at a location and the prospective benefits that are going to be obtained in future. Thus, in location planning, the ultimate challenge lies in selecting the best site for the facility (Jayaraman and Ross, 2003).

Facility location decisions are critical elements in strategic planning for every firm irrespective of their being private or public. The consequences of setting up facilities are long lasting and broad based and long-lasting as it impacts numerous operational and logistical decisions.

High cost and time, associated with property acquisition and facility construction, make facility location or relocation projects long-term investments. Thus, decision makers must select sites that will not simply perform well according to the current system state, but should continue to be profitable over its entire lifetime even if environmental factors change, population shifts or new market-trends evolve. Finding best facility location is thus a difficult task and quite demanding as decision makers have to account for uncertain future events.

In particular, revenue and costs both are also affected by facility location. Facility location planning must be done such that plant should be operated for maximum operating economy and effectiveness.

This is a top level issue on the strategic agendas of contemporary manufacturing and service firms. Particularly in this age of global markets and production environment, dramatic changes in international trade agreements have made the world truly a "global factory", allowing companies greater flexibility in their location choices. In practice, however, the question of location is very much linked to two competitive imperatives: (*i*) the need to produce close to the customer due to time-based competition, trade agreements, and shipping costs, and (*ii*) the need to locate near the appropriate labour pool to take advantage of low wages and/or high technical skills.

Location planning is closely linked with capacity planning, and this is explained in the next section.

Capacity planning: Like location planning, capacity planning also has a long-term decision focus. It deals with the firm's overall level of resources. This type of planning is done for a time horizon long enough to engage huge resources for operations. Capacity planning affects production lead time, customer responsiveness, operating cost and the ability of a company to compete in a given market. Inadequate capacity can lead to the loss of customers and so of the business.

At the same time, excess capacity can drain the company's resources and will prevent investment flowing into other more lucrative ventures. Getting answers for the questions "whether capacity of the partners should be increased/decreased?" and "by how much?" are the critical decisions of capacity planning.

In particular, capacity planning is the process of determining the production capacity needed for a factory at a location in order to meet long term demands. In the context of capacity planning for production, "capacity" is the maximum amount of work that an organization is capable of completing in a given period of time. Similar is the concern for deciding throughput capacity and storage capacity.

In practice, these planning issues are to be handled in an integrated manner as it helps in obtaining more profit (Park, 2005). Decades back in itself, the importance of the relations between the members has been recognized. "Coordinated supply chain management" came into being as it emphasizes the aspect of coordination among the different components of the supply chain. The availability of data and information technology tools derive SC using the advances in technology and communication systems.

It has also created an atmosphere for coordination inside the supply chain. Different models for the integration of above-mentioned decision-making problems have been proposed in the literature. Every supply chain has its own planning focus, and they may differ from each other in terms of the degree of coordination desired amongst the members of the chain.

Different types of problems that have been considered in the literature for planning and integration of a supply chain are described in the next section. All the planning issues considered in the literature for different supply chain environments are summarized in Table 2.1.

Table 2.1: Planning issues Considered in the Literature for Different Supply Chain Environment

Sl. No.	Planning Issues	Authors
1	***Network planning***	Peng *et al.* (2022)
2	***Supply planning***	Aghajani, *et al.*. (2023)
3	***Inventory planning / control***	Zietsman and van Vuuren (2023)
4	***Production planning***	*Bogoviz et al. (2023)*
5	***Distribution/Logistics planning***	Tiwari, *et al.* (2023)
6	***Location planning***	Caramia and Pizzari (2022)
7	***Capacity planning***	O'Connor *et al.* (2023)

SUMMARY

In this paper authors have discussed the important planning issues of the supply chain management discussed by the researchers in their research articles. Authors have elaborated these issues in detail. The issues discussed in this paper are basic issues which can be utilized by the practitioners in order to plan the supply chain depending upon the actual situation as depicted in the paper. In further research, mathematical model can be built to address the issues portrayed in this paper.

REFERENCES

[1] Aissaoui, N., Haouari, M. and Hassini, E. (2007). Supplier selection and order lot sizing: a review. Computers and Operations Research, 34 (12), 3516-3540.
[2] Allahverdi, A., Ng, C. T., Cheng, T. C. E. and Kovalyov, M. Y. (2008). A survey of scheduling problems with setup times or costs. European Journal of Operational Research, 187(3), 985–1032.
[3] Amid, A., Ghodsypour, S. H. and O'Brien, C. (2011). A weighted max–min model for fuzzy multi-objective supplier selection in a supply chain. International Journal of Production Economics, 131 (1), 139–145.
[4] Amin, S. H., Razmi, J. and Zhang, G. (2011). Supplier selection and order allocation based on fuzzy SWOT analysis and fuzzy linear programming. Expert Systems with Applications, 38 (9), 334–342.
[5] Awasthi, A., Chauhan, S. S., Goyal, S. K. and Proth, J.-M. (2009). Supplier selection problem for a single manufacturing unit under stochastic demand. International Journal of Production Economics, 117 (1), 229–233.
[6] Basnet, C. and Leung, J. M. Y. (2005). Inventory lot-sizing with supplier selection. Computers & Operations Research, 32 (1), 1–14.
[7] Bharadwaj, N. (2004). Investigating the decision criteria used in electronic components procurement. Industrial Marketing Management, 33 (4), 317–323.
[8] Bogoviz, A. V., Kurilova, A. A. Tarasova, I. A., Litvinova, T. N., Likholetov, E. A. (2023). Chapter 8 - Production planning and supply chain management under the conditions of Industry 4.0. Advances in Mathematics for Industry 4.0, Chapter-8, 189-210.
[9] Caramia, M. and Pizzari, E. (2022). Clustering, location, and allocation in two stage supply chain for waste management: A fractional programming approach. Computers & Industrial Engineering, 169, https://doi.org/10.1016/j.cie.2022.108297.
[10] Chan, W. M., Ibrahim, R. N. and Lochert, P. B. (2003). A new EPQ model: integrating lower pricing, rework and reject situations. Production Planning and Control, 14 (7), 588–595.

[11] Chen, Z.-L. (2004). Integrated production and distribution operation: taxmony, model and review. In D. Simchi-Levi, S. Wu and Z.-J. Shen, Handbook of quantitative supply chain analysis: modeling in the e-business era (pp. 711-735). Kluwer Academic Publishers.
[12] Chopra, S., Meindl, P. and Kalra, D. V. (2011). Supply chain management: strategy, planning and operation. Pearson Education Inc., India.
[13] Gupta, A. and Maranas, C. D. (2003). Managing demand uncertainity in supply chain planning. Computers and Chemical Engineering, 27 (8-9), 1219-1227.
[14] Haksever, C. and Moussourakis, J. (2005). A model for optimizing multi-product inventory systems with multiple constraints. International Journal Production Economics, 97 (1), 18–30.
[15] Haksever, C. and Moussourakis, J. (2008). Determining order quantities in multi-product inventory systems subject to multiple constraints and incremental discounts. European Journal of Operational Research, 184 (3), 930–945.
[16] Hertz, S. and Alfredsson, M. (2003). Strategic development of third party logistics providers. Industrial Marketing Management, 32 (2), 139–149.
[17] Jayaraman, V. and Ross, A. (2003). A simulated annealing methodology to distribution network design and management. European Journal of Operational Research, 144, 629–645.
[18] Jung, H., Jeong, B. and Lee, C.-G. (2008). An order quantity negotiation model for distributor-driven supply chains. International Journal of Production Economics, 111 (1), 147–158.
[19] Li, L. and Zabinsky, Z. B. (2011). Incorporating uncertainty into a supplier selection problem. International Journal of Production Economics, 134 (2), 344–356.
[20] Mafakheri, F., Breton, M. and Ghoniem, A. (2011). Supplier selection-order allocation: A two-stage multiple criteria dynamic programming approach. Intinternation Journal of Production Economics, 132 (1), 52–57.
[21] Mendoza, A. and Ventura, J. A. (2010). A serial inventory system with supplier selection and order quantity allocation. European Journal of Operational Research, 207 (3), 1304–1315.\
[22] O'Connor, E.**, Evers**, Natasha and Vega, A. (2023). Port capacity planning – A strategic management perspective. Marine Policy, 150, https://doi.org/10.1016/j.marpol.2023.105537.
[23] Park, Y. B. (2005). An integrated approach for production and distribution planning in supply chain management. International Journal of Production Research, 43 (6), 1205–1224.
[24] Peng, J. Chen, L. and Zhang, B. (2022). Transportation planning for sustainable supply chain network using big data technology. Information Sciences, 609, Pages 781-798.
[25] Rezaei, J. and Davoodi, M. (2008). A deterministic, multi-item inventory model with supplier selection and imperfect quality. Applied Mathematical Modelling, 32 (10), 2106–2116.
[26] Santoso, T., Ahmed, S., Goetschalckx, M. and Shapiro, A. (2005). A stochastic programming approach for supply chain network design under uncertainty. European Journal of Operational Research, 167 (1), 96–115.
[27] Stadtler, H. (2005). Supply chain management and advanced planning—basics, overview and challenges. European Journal of Operational Research, 163 (3), 575–588.
[28] Taylor, D. A. (2004). Supply chains: a manager's guide (2 ed.). Pearson Education.
[29] Wadhwa, V. and Ravindran, A. R. (2007). Vender selection in outsourcing. Computers and Operations Research, 34 (2), 3725-3737.
[30] Wu, D. D., Zhang, Y., Wu, D. and Olson, D. L. (2010). Fuzzy multi-objective programming for supplier selection and risk modeling: A possibility approach. European Journal of Operational Research, 200 (3), 774–787.
[31] Yücel, A. and Güneri, A. F. (2011). A weighted additive fuzzy programming approach for multi-criteria supplier selection. Expert Systems with Applications, 38 (5), 6281-6286.
[32] Tiwari, S., Sharma, P., Choi, T-M., Lim, A. (2023). Blockchain and third-party logistics for global supply chain operations: Stakeholders' perspectives and decision roadmap. Transportation Research Part E: Logistics and Transportation Review, 170, https://doi.org/10.1016/j.tre.2022.103012.
[33] Zietsman, H. J. and van Vuuren, J.H., (2023). A generic decision support framework for inventory procurement planning in distribution centres. Computers & Industrial Engineering, 177.

CHAPTER-4.2

Innovative Development in Evacuated Tube Solar Collector

Saifullah Zaphar[1], Dr. Bharat VPS Rawat [2]
[1]Associate Professor, JB Institute of Technology, Dehradun, Uttrakhand, India
saifullah.zafar@jbitdoon.edu.in

Abstract*: Solar energy is the ultimate renewable energy source utilized in evacuated tube solar collectors (ETSC functioning. The net-zero building concept is widely used in the research and development sector in energy-efficient building technology. In the low-temperature region, a significant portion of the energy is consumed in space heating. Hence as per the present scenario, renewable and sustainable energy plays a vital role in energy savings. Solar space heating systems are associated with solar water heating systems by evacuated tube solar collectors. This review article aims to discuss the recent advancements in evacuated tube solar collectors, considering different essential factors affecting the Performance of ETSC with its wide field of application. This study also discusses the payback period and some challenges of ETSC. A detailed analysis of the various working fluids and nanofluids was carried out to improve the evacuated tube solar collectors' overall performance and efficiency. The present review article emphasizes the recent development and improvement based on experimental, simulation and numerical studies in the last few decades. Eventually, this review presents future ideas that can be implemented to improve the performance of evacuated tube solar collectors.*

Keywords: Solar Energy, Net-zero building, Evacuated tube, Solar collectors, Nanofluid, Energy Efficiency, Space heating

Introduction

Renewable energy is critical in reducing dependence on traditional energy sources in which solar energy is widely used. India's solar energy potential is enormous. India's geographical area absorbs about 5,000 trillion kWh of power each year, with most of it receiving 4-7 kWh per square meter every day [1]. Solar collectors are also utilized to generate hot water in the water storage tank, with significantly higher thermal efficiency than photovoltaic (PV cells. One of the essential considerations in designing the solar collectors installation is the type of solar collectors[2]. Solar collectors come in various shapes and sizes, including flat plate collectors, evacuated tube collectors, etc. Because solar radiation is only available during the day, solar energy storage is a significant difficulty in power generation, space heating, and water heating applications. As a result, choosing influential collectors is vital for any solar system. During installation, the use of evacuated tube solar panels was confirmed. Evacuated tube collectors show much greater efficiency and effectiveness of solar energy than other collectors for the absorber field [3]. The evacuated tube solar collector is a device commonly used to supply heat for various purposes such as air heating, water heating, and thermal power plants, among others [4]. Official figures show that per capita power usage has risen steadily over the previous eight years, from 914 kWh in 2012-13 to 1208 kWh in the most recent fiscal year, a 32 % increase. At India's independence in 1947, demand was only 16 kWh [5]. Increased use of renewable energy resources is required to meet rising energy demand

and the depletion of traditional energy sources [6]. Solar collectorsform a heat exchanger that converts solar radiation into two types of energy: thermal energy in solar thermal applications and direct electrical power in photovoltaic applications. Solar devices capture solar radiation energy that strikes their surface, convert it to heat, and transport the heat to the working fluid running through them in the case of thermal applications [7].

Space heating accounts for 32-33% of total energy use in residential and commercial buildings worldwide. Domestic hot water production also uses roughly 24% of residential and 12% of commercial buildings, posing a significant barrier to energy-efficient building design. Fig.1 shows that world energy consumption increases tremendously every ten years based on U. S Energy information [8]. Hence, renewable solar energy plays a significant role in overcoming the energy demand. ETSCs are highly effective, and their performance is based on the solar irradiance of any region.

Methodology: This review used a systematic literature review strategy to bring out comprehensive place-based research knowledge on Evacuated tube solar collectors (ETSC and their advancement. A systematic review focus on its energy efficiency and effectiveness. The recent literature reviews are based on various factors such as design aspects, operating parameters, tracking systems, and using different working fluids to enhance efficiency [2]. Based on research findings and studies of recent advancements in ETSC, few future recommendations have been made for further research after a detailed discussion.

Evacuated Tube Solar Collectors: ETSCs are comparatively more effective because of the vacuum in annular space between two concentric glass tubes, eliminating sun-tracking by tabular arrangement and design.

Evacuated tube solar collectors: Principle of operation: The evacuated tube solar collectors' main components are the absorber, transparent glass cover, and heating source. ETSC works on the simple principle of 'Black body heat absorption principle' by which the

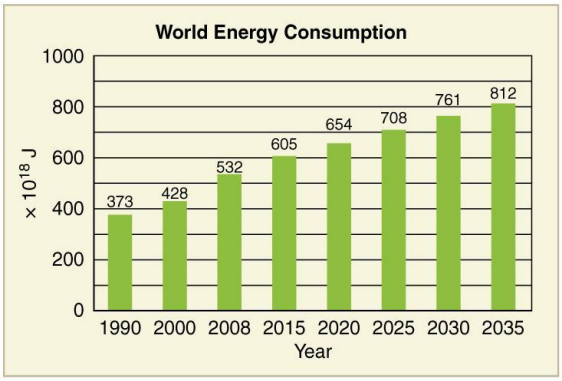


Fig. 1: Past and projected world energy use [8]

'black body absorbs the maximum amount of heat because absorptivity of the black body is maximum compared to all other colors' The ETSC in which water or space heating can be possible by using a vacuum tube. The evacuated tube is made up of borosilicate glass in two concentric tubes. The vacuum is generated between two concentric tubes. The sketch shows

that a special coating is done in the evacuated tube's inner surface vacuum tube, which is the main component that absorbs solar energy.

Thermosiphon Systems**:** In this type, water flows through the system, and when water gets warm, it rises as more extraordinary water sinks. The collectorsare installed below the storage tank so that warm water will rise into the tank. These systems do not involve any pump and are more reliable. The absorber is selectively coated to absorb all the global irradiance. Selective coatings have the highest value of absorptivity (>0.95 and negligible emissivity (<0.1

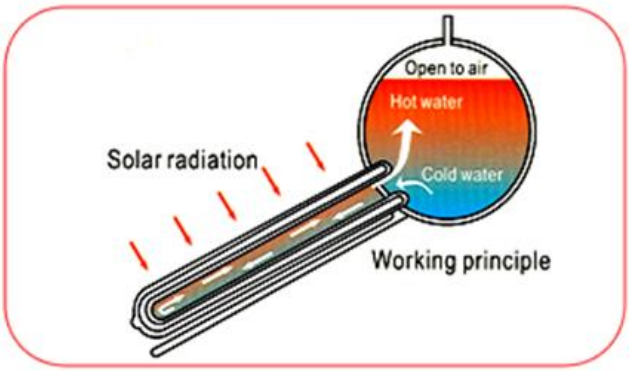


Fig. 2: Evacuated tube solar collectors working principle.

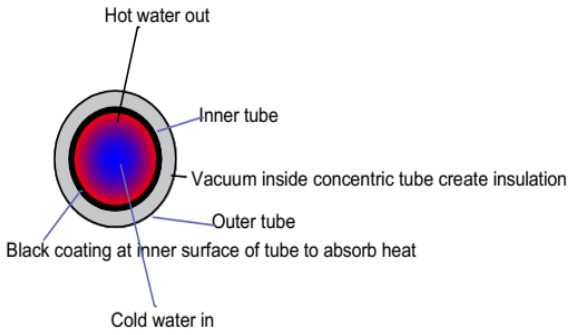


Fig. 3a: Evacuated tube inner cross-section[9]

Why is an evacuated tube solar collector (ETSC preferable to another solar collector?

Generally, FPCis designed for sunny and warm climates, and their performance decreases during cold and cloudy days; as well, it's comparatively costly and less effective than ETSC[10]. According to many researchers [11], ETSCs collect direct and diffuse radiations with excellent thermal performances with much higher efficiencies than FPC. ETSC also has convenient installation, maintenance, and transportation facility. Mangal et al. [12] mentioned that the only energy output in FPC is obtained at a mid-day peak because the sun is perpendicular to the solar collectors at mid-day. Still, in ETSC, due to the cylindrical form of the evacuated tube, sun tracking can be possible the whole day; hence peak solar energy absorption can be possible throughout the day as well because of the vacuum presence inside the evacuated tube envelope of the convective and conductive heat loss inside the evacuated tube reduces and less effected by outside low atmospheric temperature and flow of wind. The other most important factor in selecting the

ETSC is that the system does not affect if one or two evacuated tubes are broken. The capacity of hot water production and efficiency might be decreased, but the system will remain in a working position.At the same time, the repair and maintenance work can be carried out without shutting down the complete system, but if any damage occurs in FPC, then the operation has to be shut down, and then only the system can repair ([13]. An ETSC can produce heat quickly, and the heat loss in the tubes during the day is negligible, while heat generation is slow for an FPC, and the heat loss in the collectors and tank is high due to daytime convection [11]. To install ETSC, grouting of the collectors is not mandatory because there is no effect of wind on the collectors because of the open space between two evacuated tubes. Still, grouting is a must in the case of FPC, and there are many limitations during the installation of FPC. As per the industry feedback, the overall performance of ETSC is satisfactory, and many research scopes are available for space heating and cooling application compared to FPC. The most crucial feature of ETSC is that they can operate in cold climate conditions and will not damage at higher altitudes due to freezing of water or snow formation. Energy efficiency is the primary factor in space heating systems in cold regions. A hybrid space heating system combines solar energy and geothermal energy for a space heating system ([14].

Recent advancements in ETSC based on its classification and modification

The evacuated tube solar collectors is mainly classified into three types.

- ETSC with direct flow
- ETSC with U-tube flow
- ETSC with heat pipe flow

ETSC in which cold water is supplied in an insulated manifold, in which hot water is collected at a higher temperature. The manifold is connected with direct flow ETSC. Cold water gets down through an evacuated tube due to higher density, and hot water rises due to the thermosyphon effect. During the day, higher-intensity solar energy radiation strikes the evacuated tube. According to some publications, direct flow ETSC exhibit substantially higher efficiency than the conventional FPC[2].

of ETSCs tube inner cross-section, the evacuated tube comprises two concentric tubes in which the inner tube has a selective coating. It absorbs all thermal radiation that passes through, having minimum emissivity[15]. At the same time, the outer tube is exposed to sun radiation. The inner tube absorbs solar radiation that travels through the translucent outer tube. The inner tube gets heated up when sunlight travels through the outer tube. A vacuum is generated to retain the heat, enabling solar radiation to flow through but preventing heat transmission[16].The construction and functioning of evacuated tube collectors vary considerably[17]**.** Several factors can affect the collector's performance, including tube slope, flow velocity, and dust or covering. According to Weiss[18], a collector’s tilt angle of 30° to 75° has no impact on overall Performance.ETSC with a Cu-U-tube layout is commonly utilized to improve thermal efficiency and efficacy using Nanofluid or other working fluids,

Evacuated tubes with heat exchangers in the solar dryer increase the heat transfer rate of air, drying the product efficiently with less time.

A review of the performance of an evacuated tube solar collector with a sealed heat Pipe model is generally made of copper to improve the collectors' efficiency. The working fluid is kept at reduced pressure in an evacuated tube with a heat pipe, evaporating in the evaporator portion, and condensation happens at saturated temperature.The low-pressure fluid inside the heat pipe develops a capillary action pressure to pump condensed liquid from the condenser to the evaporator in close-loop circulation[19]. The ETSCs with heat pipe systems with reflectors lower convection losses while increasing exergy efficiency. The thermal oil is poured into the evacuated tube. The bulb temperature and the heating efficiency of the evacuated tube heat pipe have risen when oil is inserted into the evacuated tube**.**The temperature, heating time, and cooling time are Maximum in case 3, in which the ETSC with heat pipe taken in copper foamed metal with oil is used inside the collectors. The heat transfer rate can enhance in the case of an evacuated tube solar collector with a heat pipe using a rectangular absorber plate by increasing the contact surface area of the heat pipe [21].

Further research is recommended from the above review, creating a standard simulation tool in 2020 that can calculate the device output parameters under design conditions and collecting training datasets from pilot projects from which simulation validation and experimental results can obtain. Optimizing the required solar system, including the control system and superstructure operation, improves the system's overall performance parameters[22].

It has been experimentally proved that an evacuated heat pipe collector (ETHPC performs much better than a traditional flat-plate collectors[23]. The heat pipe comprises copper tubing, and the evaporator, adiabatic, and condenser portions are 1700, 100, and 200 mm long, respectively. A copper plate is finned in the evaporator area to improve solar input[24].The result was obtained by a solar-assisted space heating system based on the following factors. i.e., solar radiation intensity, yearly weather data, number of sunny days per year, and solar collectors area. The increase in the wind velocity contributes to the decrease in both the energy and exergy efficiency of the evacuated tube solar collectors[25]. In the ETSC-by increasing the number of the evacuated tube with the heat pipe increases both absorber surface area and absorbed energy; however, the temperature difference between the working fluid and heat pipe is maximum at the inlet section of the tube, which leads to maximum heat transfer coefficient and subsequently the temperature difference decreases after passing through other tubes. Hence, the rate of heat transfer and increase in temperature reduces due to an increase in the total number of tubes[26]. Heat pipe solar collectors have a high potential regarding both state-of-art. The heat transfer rate can enhance in the case of an evacuated tube solar collector with a heat pipe using a rectangular absorber plate by increasing the contact surface area of the heat pipe, as shown in Fig.4.

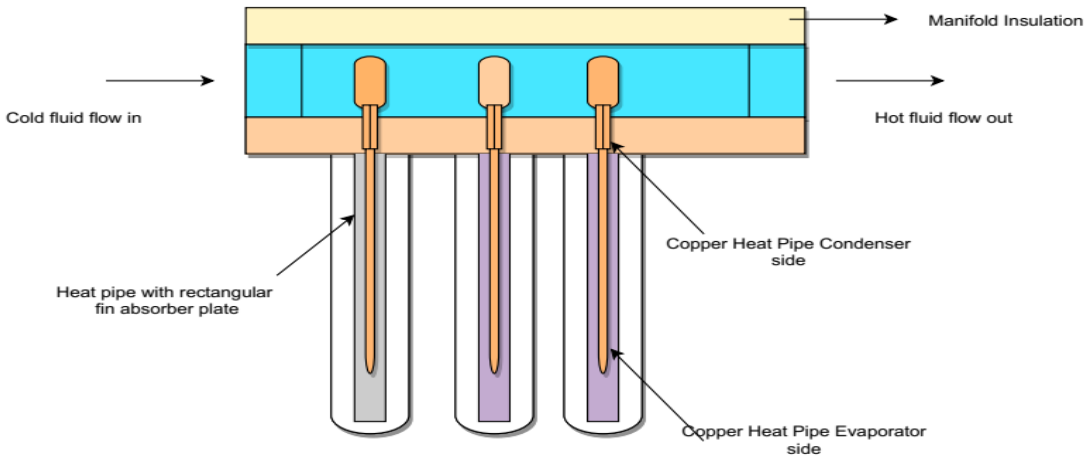


Fig. 4: Evacuated tube solar collectors with heat pipe with the rectangular fin absorber plate[21]

The-art collector's development and new collectors' concepts and applications. However, they still suffer from several drawbacks[27].

Factors affecting the Performance of ETSCs

ETSC Performance can be evaluated using a variety of operating parameters such as the working fluid, or Nanofluid used, angle of incident radiation, collectors inclination angle, type of reflector, mass flow rate, wind velocity, solar intensity in Watt/m^2, location, the number of sunny days throughout the year, and weather data. The thermal efficiency, optimum temperature obtained, efficacy, and rate of hot water production as a function of time are significant indicators of ETSC performance.

Effect of working fluids/Nanofluids on the Performance of ETSCs.

In the ETSCs, water is initially used as a working fluid to heat the water; later on, oil and air are the most common working fluids used in solar energy systems. Still, the thermal conductivity of these fluids is relatively low. It was found that adding propylene glycol with water as a working fluid in ETSC with a heat pipe resulted in an increased temperature difference with increased exergy efficiency and thermal efficiency. This conclusion is consistent with the experimental investigations carried out by[28]. Who studiedto increase the overall performance of an evacuated tube solar collectors with a thermosyphon heat pipe, chloroform, and acetone showing the best results in terms of energy and exergy performance of the thermosyphon heat pipe evacuated tube collectors (THPETC.Evacuated tube solar collectors coupled with solar desalination systems using therminol as a working fluid in evacuated tubes enhance the efficiency and production of freshwater and condensation rate[29].Researchers are now looking into new working fluids, such as nanofluids, rather than water and air, to improve collectors' performance. Nanofluids comprise base liquid and nanomaterials with improved thermophysical properties like thermal conductivity, diffusivity, and convective heat transfer coefficients. Nanofluids increase solar collectors' optical characteristics, transmittance, and extinction coefficient and boost heat transfer efficiency. As time passes, the water temperature rises, increasing solar radiation and a maximum

temperature of 64^0 degrees Celsius[30]. It is possible to enhance the efficiency of evacuated tube collectors by adding a trim concentration level of 1.5 to 2.0 volume by creating a mirror from a part of the inner concave surface of a glass tube. U-tube is installed inside the evacuated tube solar collectors using nanofluids, and it found that the maximum thermal efficiency is achieved with a 4% nanofluid volume concentration[31]. U-tube solar collectors with aluminum oxide Nanofluid concentration enhance the maximum efficiency by 72.4%[32]. High temperatures can be achieved by adopting a vacuum between the glass cover and the absorber plate to reduce or eliminate convection losses[33]. Carbon dioxide as a working fluid is used in evacuated tube solar collectorswhere the CO_2 temperature difference occurs from 35^0C to 78^0C and gives a maximum temperature difference of 43^0C[34].Nanofluids are designed to prepare fluids by dispersing nano-sized metal or metal oxide particles dispersed in liquids like water. Nanofluids possess higher thermal conductivity[35]. The evacuated tube heat pipe solar collectors using TiO_2 nanoparticles mixed in distilled water enhanced the efficiency by 16.7% at a flow rate of 2.7 liters per minute. TiO_2 nanofluid has a higher temperature difference than water. The presence of TiO_2 nanoparticles enhances the thermal properties compared to water. These enhancements increase the capability to transfer heat from the absorber plate to the working fluid. Different Types, sizes, and content in %age of volume fraction of nanoparticles also play a significant role in enhancing the rate of heat transfer, thermal properties of the Nanofluid, overall effectiveness, and efficiency of the evacuated tube solar collectors. Maximum solar collector's efficiency occurs at a 5% volume fraction of Nanofluid in distilled water[36]. In another paper, the thermal analysis was taken by another nano fluid-like grapheme water (0.2 % Concentration. The reading was obtained for temperatures at the different quantities of fluid capacity in the tank. The maximum temperature increases with decreases in the quantity of Nanofluid.

As well as the reading obtained with and without a reflector at the same condition and with different quantities of the working fluid. The temperature rises with the reflector and increases up 70^0C[37].ETSC also gives good results at a high flow rate and downward flow direction[38]. The critical properties of carbon dioxide as a working fluid have a high volumetric capacity and higher heat transfer coefficient than other working fluids. They are thermally stable for a wide range of temperatures. Carbon dioxide's other properties are abundant in nature, nonpoisonous, non-flammable, and environment friendly with lower global warming potential.

In the study of evacuated tube solar collectors, $CO_2$is a working fluid, and using parabolic collectors or external compound parabolic collectors in both the reflector and the working fluid temperature increases the efficiency of the evacuated tube collectors decreases. At the maximum temperature of 200^0C, the collectors' efficiency becomes 40%. As well as the main challenge is to maintain high operating pressure inside the collectors[39].

In an evacuated tube solar collectors with supercritical CO_2 as a working fluid, the results show that the temperature, pressure, and mass flow rate increase with the solar radiation, which is different from those of traditional solar collectors using liquid as the working fluid.

The annually averaged collector's efficiency is above 60.0% in the case of supercritical CO_2 as a working fluid, which is much higher than water-based solar collectors[40].

As per the previous study, supercritical carbon dioxide is used as a working used in evacuated tube solar collectors for solar water heating systems in which the heat transfer can take place by natural convection without using the pump. The thermal efficiency can achieve up to 90.4%, which is comparatively higher than other solar water heating systems. In this system, sufficient hot water in summer can produce at 78^0C[41].

During a typical day of operation, the effects of employing water, ammonia, acetone, methanol, and pentane as working fluids of the built-in heat of the pipe are compared. From an economic and technological standpoint, it has been proven that the performance of a solar water heater can be improved by up to 28% and 50%, respectively[42].

The collectors comprise five evacuated tubes that are filled with regular engine oil. The working fluid is carried through an extra stainless-steel pipe incorporated with the tubes. 5 U-shape twists are formed by bending the steel pipe (through-flow pipe 5 times. Every U-turn is contained within a single evacuated tube. The number of evacuated tubes should be increased, and the stainless-steel pipe diameter should be raised. At the same time, the length is lowered to improve the system's performance and make it suited for larger loads, e.g., creating superheated steam[43].

The heat gained by the working fluid increases with solar intensity. Heat transfer from the outer glass to the U-type copper or aluminum tube will be higher at higher solar intensity. Subsequently, there will be a higher potential for convective heat transfer between the lower surface of the U tube and the working fluid. The model predictions are compared with experimental data, and a good agreement is observed between them. Aqueous lithium chloride solution (LiCl-H_2O, water, and air are chosen as working fluids[44].

Performance analysis of ETSC based on reflector and absorber: The reflectors and absorbers in the evacuated tube solar collector are essential in enhancing thermal efficiency and optimum temperature range. The research has been carried out to select reflector material and configuration of material in which mirror is considered the best than other reflector materials like white paint or aluminum foil. The flat and zigzag geometry of reflectors also provides the best results[41]. This reflector can focus radiation on an absorber plate inside the tube. External radiation concentrations can also be coupled to an evacuated collector for performance enhancement over the simple[42].

The reflectors are used to enhance thePerformance of ETSC. In the case of a reflector, ETSC gives a higher temperature difference and has better thermal efficiency than the case without a reflector[43]. The Performance of ETSC depends on the absorber shape and geometry configuration inside the tube and evacuated tube arrangement with the proper angle of solar irradiation.

Kim and Seo[44] worked on different absorber shapes with different arrangements of absorber plates. U tube of copper is inserted inside the evacuated tube where fluid flow occurs.Four

models were studied based on the absorber's solar irradiation angle and shape. Regarding the beam radiation consideration, overall, model II gave the best performance among all models, and the absorbing area of the tube increases the overall performance of the collector also increases[44].

The cheapest and least effective tor is a diffuse reflection with a simple surface. V-trough and cylindrical reflectors are more commonly used because of their superior performance and ease of production.

The collector's efficiency has increased by 2% due to improved transmittance from 0.91 to 0.96 and antireflection coatings[46]. The only factors that influence the reflection of beam radiation are the incidence angle and collector geometry[47]. A compound parabolic reflector improves optical efficiency by 66 % at a normal incidence angle[56]. The optical efficiency of a Fresnel lens is reduced by 6.3 % while the thermal efficiency is raised[48]. Thermal efficiency is reduced due to optical and thermal losses.

Review of performance based on operating parameters: Various factors affect the performance of evacuated tube solar collectors. Based on the working fluid flowing inside the evacuated tube, some of the critical factors are the mass flow rate of the working fluid Optical properties of the absorber tube materials based on the coating, design of collector geometry and contact surface area, angle of inclination of an evacuated tube, and by application of a reflector to enhance the intensity of the radiation(Kumar et al., 2021. (Gao et al.,2011 examined the effects of thermal flow and mass rate on solar hot water systems with forced circulation.

Two types of ETSCs were investigated for the system: water in a glass and U-pipe evacuated collectors. WGETSC and UPETSC were compared in terms of their energy efficiency. UPETSC has a 25–35 percent larger energy storage capacity than WGETSC, according to the comparison. The flow rate and fluid thermal mass impact energy storage and pump operations.

A proper mass flow rate is necessary to keep the pump running smoothly and extract energy from the collector promptly and efficiently. It should be mentioned that when the flow rate increases, the performance of energy collecting decreases (El-Nashar,2001.

Table 1 Previous Research outcomes on different working fluids and types of ETSC

Author	**Type of Investigations**	**Working Fluid**	**Key findings**
Areas, C.[54]	Experimental	Water	cold climates, the evacuated tube collectors perform better.
H. Zhang et	Experimental	CO_2	e thermal-hydraulic Performance of CO_2 is

al. [55]			influenced by its mass flux, heat flux, operating pressure, and cross-section shape.
X. W. Zhang et al.[56]	Experimental	CO2	e results reveal that natural convection may quickly generate supercritical CO_2 flow circulation in this solar heater without a driving pump. to 90.4 % heat recovery efficiency is achieved, higher than most standard solar water heater systems.
Heater. [57]	Experimental	CO_2	e thermosiphon solar water heater of claim 1, wherein carbon dioxide circulates through the U - shaped tube in the glass tube under gravity as the carbon dioxide upon cooling becomes heavier and returns to the U - shared tube in the glass tube through the cold manifold.
(Yamaguchi et al.[58]	Experimental	CO_2	lar heating or water cooling may readily create a natural convection flow of supercritical carbon dioxide. This convective flow collects and transmits heat from solar collectors tubes to water.
(X. R. Zhang et al.[59]	Experimental	CO_2	Feasibility Study of CO2Based Rankine Cycle powered by solar energy. The maximum temperature of CO_2 can achieve up to 185^0 C.

Application of ETSC: The most suitable device for solar thermal applications has been evacuated tube solar collectors67. The main application of ETSC is either for domestic purposes, for example, in residential homes, or industrial applications, such as in pharmaceuticals, textiles, paper, and leather industries, swimming pools, boiler houses, hospitals, and nursing homes. Some of the applications identified by several researchers include water heating, air drying, air heating, and desalination are just a few of the many uses for ETSCs. The researchers have studied ETSCs, which may be utilized for cooling and heating systems. Evacuated tubes with a heat exchanger in the solar dryer increase the heat transfer rate of air, drying the product efficiently with lesstime. All use of ETSCs in different components of domestic life, namely water heating, roof heating, kitchen, washing machine, space heating, etc. Nowadays, each household consumes a considerable quantity of energy

daily. We can install efficient ETSCs with proper hot water storage technologies and proper utilization in cold regions to reduce unit power consumption.

Challenges and remedies of using ETSCs: Specific challenges arise after using ETSCs for domestic water heating applications. ETSCs tube is comparatively more efficient than FPC. It becomes pretty hot, reaching the boiling point of water during the hot summer month due to the vacuum inside the tube, leading to overheating and breaking the evacuated tubes. To overcome this common problem, cold water with hot water ensures the temperature and pressure should not exceed the desired limit[68]. In the extreme winter season, when the surrounding temperature is shallow and snowfall occurs, the snow falls stuck on the evacuated tube, forming the snow layer on the ETSC. This happens because the outer surface of the evacuated tube is not heated. Hence ultimately, the efficiency and effectiveness of ETSCare hampered because the solar energy could not reach to evacuated tube due to snow formation. Hence, we need to remove snow every morning, which is tedious work.Fragility two layers of annealed borosilicate glass are used to construct evacuated tubes, and annealed glass is far more fragile than tempered glass. Glass tubes are easily fractured due to their fragility and can be destroyed by small hail, jostling, or bad handling. As a result, particular caution must be exercised when transporting or handling evacuated tubes[69].

Economic considerations of the usage of ETSC: Evacuated tube solar collectors (ETSCs have been commercially available for over 20 years. The evacuated tube solar water heater market has recently witnessed a considerable expansion in China, Europe, Japan, and India due to the fast-growing industries of ETSCs. This study attempted to identify the economic advantages of ETSCs over other solar collectors by examining the original manufacturing and installation costs, operating and maintenance costs, and the payback period. According to data from AEE INTEC on cost analysis of various solar thermal collectors and comparisons based on specific cost per meter square (m^2 and gross area in m^2, ETSCs have a lower specific cost per m^2 and a higher gross area than FPC, an air collector, and a parabolic trough collectors[70]. According to an economic analysis of roof-integrated concrete solar collectors, evacuated tube collectors have a short payback period, which means that the investment cost can be repaid quickly. Evacuated tubes provide environmental benefits by reducing greenhouse gas emissions and air pollution[71]. The evacuated tube that has been used in ETSCs is the best choice in terms of the minor effects caused during their manufacture. However, from a financial standpoint, it is evident that a more significant expenditure is required to obtain the evacuated tube collectors system. Still, the operation and maintenance cost is comparatively significantly less[72]. As a result, an ETSC is more cost-effective and affordable in the long run than other solar collectors. Recent large-scale production and deployment of evacuated tubes have demonstrated that this technology is mature, with a three-year payback period without subsidies[68].

Discussion: Following a review of ETSC's significant developments based on several points of debate, such as its geometric layout, use of different kinds of the working fluid, Nanofluid, adjustment of operating parameters, use of reflectors, and so on, ETSCs is an example of one

of the ideal types of solar collectors which can be operated on medium temperature levels because of shallow thermal losses and since between two concentric glass tube vacuum minimize in conduction and convection losses, but radiation losses exist. Selective coatings that increase absorbance while minimizing emittance can reduce radiation losses. Stationary evacuated tube solar collectors have a temperature range of 50–200 °C, while stationary flat plate solar collectors have 30–80 °C[73]. The main goal of this review is to show the key aspects that can improve the efficiency of evacuated tube solar collectors. If the convective heat transfer coefficient between the absorber tube and the working fluid is higher, the efficiency of the evacuated tube solar collectors will be higher. Using an effective heat exchanger, ETSCs can be improved by using high thermal conductivity working fluid and nanofluids. The overall performance of ETSCs refers to their efficiency and efficacy, determined by some parameters such as the collector's design, the optical properties of the absorber tube, and the working fluid inside the tube.

The previous work done on ETSCs nanofluid is well explained with the help of the table. 2 in which the complete detailed information of Nanofluid with outcomes is explained[74]. MWCNT, Al2O3, CuO, SiO2, and TiO2 nanoparticles, as well as a mixture of propylene glycol and water as the base fluid, resulted in a 10.5 percent better efficiency, or 66 percent when 0.2 volume percent of MWCNT nanofluid was used. The effect on the thermophysical properties of different nanofluids with varying particle sizes, nanoparticle mass fraction, tube dimensions, and circulation rate can improve ETSC efficiency.

Cu–water has the highest thermal recovery efficiency of all the nanofluids[75].CuO mass concentration significantly impacts heat transport, with a value of 1.2 percent corresponding to the best results. Most refrigerants, as the working fluid of ETSCs, also give excellent results. Moreover, Yurddaş.[74] found 76% efficiency experimentally using R-134a in a circular design of ETSC. Efficiency can be increased using nano-coatings of high-absorbance materials on the absorber tube. The performance of heat pipe ETC is higher than direct flow ETSC[76]. A concentric tube inside the absorber tube with phase change material can be investigated experimentally and numerically. More specifically, Chopra et al.[77] used SA-67 as PCM and found a thermal efficiency of up to 87.8%.

Nomenclature & Abbreviation

ETSCs	evacuated tube Solar Collectors
PV	photovoltaic
FPC	flat plate collectors
COP	coefficient of performance
PV/T	photovoltaic thermal
HVAC	heating,ventilation & Air conditioning
ETHPSC	evacuated tube heat pipe solar collectors

THPETSC	thermosyphon heat pipe evacuated solar tube solarcollectors
WGETSC	water in glass evacuated tube solar collectors
UPETSC	U pipe evacuated tube solar collectors
NCL	natural circulation loop
IMD	India meteorological department
PCM `	phase change material

References:

[1] MNRE. (n.d.. Retrieved February 25, 2021,)from https://mnre.gov.in/solar/current achieved 5th,and has achieved grid parity.

[2] Kumar, A., Said, Z., & Bellos, E. (2021. An up-to-date review on evacuated tube solar collectors. Journal of Thermal Analysis and Calorimetry, 145(6, 2873–2889. https://doi.org/10.1007/s10973-020-09953-9

[3] Lazzarin, R. (2020. Heat pumps and solar energy: A review with some insights in the future. International Journal of Refrigeration, 116, 146 160. https://doi.org/10.1016/j.ijrefrig.2020.03.031

[4] Shadab Ahmad, S. A. (2018. Design of Solar Evacuated Tube Collectors for Low-Intensity Thermal Energy. International Journal of Applied Engineering Research, January.

[5] Mallapur Chaitanya. (2021. India's per capita power consumption is rising, but wide variations persist across states. In Money Control (p.1.https://www.moneycontrol.com/news/trends/current-affairs-trends/indias-per-capita-power-consumption-rising-but-wide-variations-persist-across-states-6663841.html)

[6] Farhana, K., Kadirgama, K., Rahman, M. M., Ramasamy, D., Noor, M. M., Najafi, G., Samykano, M., & Mahamude, A. S. F. (2019. Improvement in the performance of solar collectors with nanofluids-A state-of-the-art review. Nano-Structures & Nano-Objects, 18, 100276.

[7] Chang, H., Duan, C., Wen, K., Liu, Y., Xiang, C., Wan, Z., He, S., Jing, C., & Shu, S. (2015. A modeling study on the thermal performance of a modified cavity receiver with glass window and secondary reflector. Energy Conversion and Management, 106, 1362–1369.

[8] World Energy Use | Physics. (n.d.. https://courses.lumenlearning.com/physics/chapter/7-9-world-energy-use/

[9] RED SUN,Evacuated tube Collectors Solar Water Heater. (n.d.. Retrieved February 24, 2021, from https://www.redsunin.com/products/evacuated-tube-collectors-solar-water-heaters/

[10] Alternate Energy Tutorials. (n.d.. Retrieved February 25, 2021, from https://www.alternative-energy-tutorials.com/solar-hot-water/evacuated-tube-collectors.html

[11] Ayompe, L. M., Duffy, A., Mc Keever, M., Conlon, M., & McCormack, S. J. (2011. Comparative field performance study of flat plate and heat pipe evacuated tube collectors (ETCs for domestic water heating systems in a temperate climate. Energy, 36(5, 3370–3378. https://doi.org/10.1016/j.energy.2011.03.034

[12] Mangal, D., Lamba, D. K., Gupta, T., & Jhamb, K. (2010. Acknowledgment Of Evacuated Tube Solar Water Heater Over Flat Plate Solar Water Heater. International Journal of Engineering, 4(4, 279–284.

[13] Tang, R., Yang, Y., & Gao, W. (2011. Comparative studies on the thermal performance of water-in-glass evacuated tube solar water heaters with different collectors tilt-angles. Solar Energy, 85(7, 1381–1389.

[14] Xu, W., Liu, C., Li, A., Li, J., & Qiao, B. (2020. Feasibility and performance study on hybrid air source heat pump system for ultra-low energy building in severe cold region of China. Renewable Energy, 146, 2124–2133. https://doi.org/10.1016/j.renene.2019.08.079

[15] Bermel, P., Lee, J., Joannopoulos, J. D., Celanovic, I., & Soljacie, M. (2012. Selective Solar Absorbers. Annual Review of Heat Transfer, 15(15, 231–254.

[16] Zubriski, S. E., & Dick, K. J. (2012. Measurement of the efficiency of evacuated tube solar collectors under various operating conditions. Journal of Green Building, 7(3), 114–130.

[17] Siva Kumar, S., Kumar, K. M., & Kumar, S. R. S. (2017. Design of Evacuated Tube Solar Collectors with Heat Pipe. Materials Today: Proceedings, 4(14), 12641–12646.

[18] Abo-Elfadl, S., Hassan, H., & El-Dosoky, M. F. (2020. Energy and exergy assessment of integrating reflectors on thermal energy storage of evacuated tube solar collectors-heat pipe system. Solar Energy, 209(June), 470–484.

[19] Abd-Elhady, M. S., Nasreldin, M., & Elsheikh, M. N. (2018. Improving the performance of evacuated tube heat pipe collectors using oil and foamed metals. Ain Shams Engineering Journal, 9(4, 2683–2689.

[20] Kalogirou, S. A. (2016. Nontracking solar collection technologies for solar heating and cooling systems. In Advances in Solar Heating and Cooling. Elsevier Ltd.
[21] Zhang, X., Yang, J., Fan, Y., Zhao, X., Yan, R., Zhao, J., & Myers, S. (2020. Experimental and analytic study of a hybrid solar/biomass rural heating system. Energy, 190, 116392.
[22] Speyer, E. (1965. Solar energy collection with evacuated tubes. Journal of Engineering for Gas Turbines and Power, 87(3), 270–275.
[23] Chun, W., Kang, Y. H., Kwak, H. Y., & Lee, Y. S. (1999. Experimental study of the utilization of heat pipes for solar water heaters. Applied Thermal Engineering, 19(8), 807–817.
[24] Siuta-Olcha, A., Cholewa, T., & Dopieralska-Howoruszko, K. (2020. Experimental studies of thermal performance of an evacuated tube heat pipe solar collectors in Polish climatic conditions. Environmental Science and Pollution Research. https://doi.org/10.1007/s11356-020-07920-3
[25] Shafieian, A., Khiadani, M., & Nosrati, A. (2019. Thermal performance of an evacuated tube heat pipe solar water heating system in cold season. Applied Thermal Engineering, 149(August 2018), 644–657.
[26] Ersöz, M. A. (2016. Effects of different working fluid use on the energy and exergy performance for evacuated tube solar collectors with thermosyphon heat pipe. Renewable Energy, 96, 244–256.
[27] Jamar, A., Majid, Z. A. A., Azmi, W. H., Norhafana, M., & Razak, A. A. (2016. A review of water heating system for solar energy applications. International Communications in Heat and Mass Transfer, 76, 178–187.
[28] Bhargva, M., & Yadav, A. (2020. Effect of shading and evaporative cooling of glass cover on the performance of evacuated tube-augmented Solar still. Environment, Development and Sustainability, 22(5), 4125–4143.
[29] Daghigh, R., & Shafieian, A. (2016. Theoretical and experimental analysis of the thermal performance of a solar water heating system with evacuated tube heat pipe collectors. Applied Thermal Engineering, 103, 1219–1227.
[30] Kaya, H., & Arslan, K. (2019. Numerical investigation of efficiency and economic analysis of an evacuated U-tube solar collectors with different nanofluids. Heat and Mass Transfer/Waerme- Und Stoffuebertragung, 55(3), 581–593.
[31] Kim, H., Kim, J., & Cho, H. (2017. Experimental study on performance improvement of U-tube solar collectors depending on nanoparticle size and concentration of Al2O3 Nanofluid. Energy, 118, 1304–1312.
[32] Ghoneim, A. A., Shabana, H. M., Shaaban, M. S., & Mohammedein, A. M. (n.d.. Performance Analysis of Evacuated Tube Collectors in Hot Climate. 8–20.
[33] Abas, N., & Khan, N. (2016. A Thermosyphon driven Solar Water Heater Using CO 2 as Working Fluid. Journal of Applied Environmental and Biological Sciences, 6, 43–54.
[34] Carmichael, L. T., Berry, V., & Sage, B. H. (1963. Thermal Conductivity of Fluids. Ethane. In Journal of Chemical and Engineering Data (Vol. 8, Issue 3, pp. 281–285.
[35] Series, I. O. P. C., & Science, M. (2020. An experimental investigation on the effect of hybrid Nano fluid (Al + Al_2O_3 / distilled water) on the thermal efficiency of evacuated tube solar collectors. 2–9.
[36] Maustafa Mahdi, M., Abed Jaddoa, A., Falih Kadhim, I., & Asmet, W. (2020. Outdoor testing of an evacuated tube closed two phase thermosyphon solar water heater charged with Nanofluid. IOP Conference Series: Materials Science and Engineering, 765.
[37] Yadav, A., & Bajpai, V. K. (2013. Comparison of thermal performances of flat plate and evacuated tube solar air collectors at different flow rates: experimental analysis. International Journal of Renewable Energy Technology, 4(2, 107. https://doi.org/10.1504/ijret.2013.052924
[38] Duong, V., & Diaz, G. (2014. Carbon dioxide as working fluid for medium and high-temperature concentrated solar thermal systems. 2(1, 99–115. https://doi.org/10.3934/energy.2014.1.99
[39] Zhang, X. R. (2008. An experimental study on evacuated tube solar collectors using supercritical CO 2. 28, 1225–1233
[40] Zhang, X., Niu, X., & Yamaguchi, H. (2018. Study on a supercritical CO 2 solar water heater system induced by the natural circulation. 10(4, 1–15. https://doi.org/10.1177/1687814018772376
[41] Gan, Y. Y., Ong, H. C., Ling, T. C., Zulkifli, N. W. M., Wang, C. T., & Yang, Y. C. (2018. Thermal conductivity optimization and entropy generation analysis of titanium dioxide nanofluid in evacuated tube solar collectors. Applied Thermal Engineering, 145(September), 155–164.
[42] Lecturer, A., & Mohammed, A. A. (2014. Abstract :18(2), 122–132.
[43] Naik, B. K., Varshney, A., Muthukumar, P., & Somayaji, C. (2016. Modeling and Performance Analysis of U Type Evacuated Tube Solar Collectors Using Different Working Fluids. Energy Procedia, 90(December 2015), 227–237.

[44] Alhabeeb, B. A., Kadhim, T. J., Hashim, H. T., & Mohammed, H. N. (2020. Enhancement of the thermal efficiency of the evacuated tubes solar water heater by adding a reflector. International Energy Journal, 20(1), 57–66.
[45] El-nashar, A. M. (1981. Renewable Energy Systems and Desalination. Evacuated Tube Collectors, II.
[46] George, I., & Kalaivanan, R. (2017. Analysis of thermal performance on evacuated tube solar collectors without and with reflector. 55–61.
[47] Kim, Y., & Seo, T. (2007. Thermal performances comparisons of the glass evacuated tube solar collectors with shapes of absorber tube. Renewable Energy, 32(5, 772–795.
[48] El-Nashar, A. M. (2001. The economic feasibility of small MED seawater desalination plants for remote arid areas. Desalination, 134(1–3, 173–186.
[49] Kyekyere, E., Ndiritu, H., Hawi, M., & Mwambe, P. (2021. Performance of Water in Glass Evacuated Tube Solar Water Heater under Kenya Climatic Condition. April.
[50] Essa, M. A., Rofaiel, I. Y., & Ahmed, M. A. (2020. Experimental and Theoretical Analysis for the Performance of Evacuated Tube Collectors Integrated with Helical Finned Heat Pipes using PCM Energy Storage. Energy, 206, 118166. https://doi.org/10.1016/j.energy.2020.118166
[51] Thippeswamy, L. R., & Kumar Yadav, A. (2020. Heat transfer enhancement using CO2 in a natural circulation loop. Scientific Reports, 10(1, 1–10. https://doi.org/10.1038/s41598-020-58432-6
[52] Areas, C. (2020. A Comparative Study on the Performances of Flat Plate and Evacuated Tube Collectors Deployable in Domestic Solar Water Heating Systems in Di ff erent Climate Areas.
[53] Zhang, H., Guo, J., Huai, X., & Cui, X. (2019. Thermodynamic performance analysis of supercritical pressure CO2 in tubes. International Journal of Thermal Sciences, 146(September, 106102. https://doi.org/10.1016/j.ijthermalsci.2019.106102
[54] Zhang, X. W., Niu, X. D., Yamaguchi, H., & Iwamoto, Y. (2018. Study on a supercritical CO2 solar water heater system induced by the natural circulation. Advances in Mechanical Engineering, 10(4, 1–15. https://doi.org/10.1177/1687814018772376
[55] Yamaguchi, H., Sawada, N., Suzuki, H., Ueda, H., & Zhang, X. R. (2010. Preliminary study on a solar water heater using supercritical carbon dioxide as working fluid. Journal of Solar Energy Engineering, Transactions of the ASME, 132(1, 0110101–0110106. https://doi.org/10.1115/1.400035
[56] Zhang, X. R., Yamaguchi, H., Fujima, K., Enomoto, M., & Sawada, N. (2006. A feasibility study of CO2-based rankine cycle powered by solar energy. JSME International Journal, Series B: Fluids and Thermal Engineering, 48(3, 540–547. https://doi.org/10.1299/jsmeb.48.540
[57] Shahi, M., Mahmoudi, A. H., & Talebi, F. (2010. Numerical simulation of steady natural convection heat transfer in a 3-dimensional single-ended tube subjected to a nanofluid. International Communications in Heat and Mass Transfer, 37(10, 1535–1545. https://doi.org/10.1016/j.icheatmasstransfer.2010.08.005
[58] Lu, L., Liu, Z. H., & Xiao, H. S. (2011. Thermal performance of an open thermosyphon using nanofluids for high-temperature evacuated tubular solar collectors. Part 1: Indoor experiment. Solar Energy, 85(2, 379–387. https://doi.org/10.1016/j.solener.2010.11.008
[59] Mahendran, M., Lee, G. C., Sharma, K. V., & Shahrani, A. (2012. Performance of Evacuated Tube Solar Collectors using Water-Based Titanium Oxide Nanofluid. Journal of Mechanical Engineering and Sciences, 3(December, 301–310. https://doi.org/10.15282/jmes.3.2012.6.0028
[60] Mahbubul, I. M., Khan, M. M. A., Ibrahim, N. I., Ali, H. M., Al-Sulaiman, F. A., & Saidur, R. (2018. Carbon nanotube nanofluid in enhancing the efficiency of evacuated tube solar collectors. Renewable Energy, 121, 36–44.
[61] Ozsoy, A., & Corumlu, V. (2018. Thermal performance of a thermosyphon heat pipe evacuated tube solar collectors using silver-water Nanofluid for commercial applications. Renewable Energy, 122, 26–34. https://doi.org/10.1016/j.renene.2018.01.031
[62] Sharafeldin, M. A., & Gróf, G. (2019. Efficiency of evacuated tube solar collectors using WO3/Water nanofluid. Renewable Energy, 134, 453–460. https://doi.org/10.1016/j.renene.2018.11.010
[63] Mevada, D., Panchal, H., ElDinBastawissi, H. A., Elkelawy, M., Sadashivuni, K., Ponnamma, D., Thakar, N., & Sharshir, S. W. (2019. Applications of evacuated tubes collectors to harness the solar energy: a review. International Journal of Ambient Energy, 0(0, 1–18.
[64] Alternative Energy Tutorials. (2010. Evacuated Tube Collectors for Solar Hot Water System. http://www.alternative-energy-tutorials.com/solar-hot-water/evacuated-tube-collectors.html
[65] Sabiha, M. A., Saidur, R., Mekhilef, S., & Mahian, O. (2015. Progress and latest developments of evacuated tube solar collectors. Renewable and Sustainable Energy Reviews, 51, 1038–1054.
[66] Venkatacha, C., Mariam, S. G., & Chimdo Anc, A. (2018. Thermal and Economic Analysis Review on Flat Plate, Parabolic Trough and Evacuated Tube Solar Collectors for Process Heat Applications. Journal of Applied Sciences, 19(1, 1–8. https://doi.org/10.3923/jas.2019.1.8

[67] Hoffmann, R., Brondani, M., Pappis, F., Friderichs, A., Serafini, S., & Foletto, E. L. (2014. Economic-environmental comparison between flat plate and evacuated tube solar collectors. Global Nest Journal, 16(6), 1100–1110.

[68] Kalogirou, S. A. (2004. Solar thermal collectors and applications. In Progress in Energy and Combustion Science (Vol. 30, Issue 3. https://doi.org/10.1016/j.pecs.2004.02.001

[69] Kim, H., Ham, J., Park, C., & Cho, H. (2016. Theoretical investigation of the efficiency of a U-tube solar collectors using various nanofluids. Energy, 94, 497–507. https://doi.org/10.1016/j.energy.2015.11.021

[70] Yurddaş, A. (2020. Optimization and thermal performance of evacuated tube solar collectors with various nanofluids. International Journal of Heat and Mass Transfer, 152, 119496.

[71] Chopra, K., Tyagi, V. V., Pandey, A. K., & Sari, A. (2018. Global advancement on experimental and thermal analysis of evacuated tube collectors with and without heat pipe systems and possible applications. Applied Energy, 228(May, 351–389.

[72] Chopra, K., Pathak, A. K., Tyagi, V. V, Pandey, A. K., Anand, S., & Sari, A. (2020. Thermal performance of phase change material integrated heat pipe evacuated tube solar collectors system : An experimental assessment. Energy Conversion and Management, 203(July 2019, 112205.

CHAPTER-4.3

Advanced Energy Management Strategies for HVAC Systems in Smart Buildings

Saifullah Zaphar[1], Dr. Bharat VPS Rawat [2]
[1,2]Associate Professor, Department of Mechanical Engineering, JBIT, Dehradun, Uttarakhand,

Abstract- *Due to the rising worldwide energy demand and the significant portion of energy that is now utilized by buildings, there has been an increase in interest in the effectiveness of energy management systems in addressing energy consumption in buildings in recent years. Because of the size of this industry, research is being done with the aim of identifying prospective improvement paths and making them a reality with the aid of recent technical advancements that could be used to reduce the energetic footprint of buildings. The examination of how resource-efficient these systems truly are when trusted with ensuring occupant comfort design is made possible by the availability of vast volumes of historical data in building management software packages, namely in the field of heating, ventilating, and air conditioning installations.*

Keywords: Energy Management, Energy Consumption, comfort design, Heating Ventilating and air conditioning.

1. INTRODUCTION

This chapter introduces the research topic focusing on the research problem that defines the scope of the thesis, the formulation of the thesis hypotheses and finally the objectives and methodology to accomplish them during the development of this thesis. The manner in which we deal with power consumption has changed in recent years. This change has mainly been driven by the continued increase in energy demand, the difficulties associated with remaining competitive as the marketplace becomes global and the threat of instability in securing energy sources [1]. The efficiency of energy processes has been identified as a growing concern at the full range of the power spectrum, encompassing very large power consumers such as factories, medium power consumers such as buildings in the tertiary sector, or even the smaller consumers such as households. Consequently, global efforts are underway directed at raising awareness of the urgency to enable new developments and promoting further research in the field of energy efficiency to tackle current but also upcoming challenges. This is reflected by the weight of related topics in Europe's main research and innovation programs, which contains initiatives like the Horizon 2020 Programme [2]. Being the largest research and innovation program that the European Union has ever conducted, the Horizon 2020 Programme operates with a budget of approximately 80 billion euros in available funding to be allocated between 2014 and 2020 for different topics. Approximately 7.5% of the available funding is directed towards the Secure, Clean and Efficient Energy research and innovation track, while 4% is directed towards the Climate Actions, Environment and Resource Efficiency track. Both this resource allocation and the proclaimed aim of the Energy Efficiency track of the Programme of reducing the primary energy consumption by 20% by 2020, showcases the commitment of the European Union to this goal [3]. The considered avenues for action include the realization of transformational changes at all the

stages of the energy consumption chain, from generation to transformation and distribution, but having a special focus on the final stage of the energy chain.

2. METHODOLOGY

State of the art in HVAC energy management This chapter outlines the main types of solutions being currently employed on modern buildings or actively being researched for further improving the energy efficiency of HVAC systems in buildings while ensuring occupant comfort.

Building Energy Management Systems

In the future, intelligent building energy management systems will likely seek to increase:

- Cost savings on energy
- Energy efficiency
- Flexibility in power generation
- Reductions in carbon dioxide emissions
- Stability in energy provision
- Human health and safety

On a large scale, this means that building energy management systems will likely control sections of cities through microgrids that utilize renewable energy generated onsite or nearby while also integrating innovative materials that help conserve energy.

However, not all energy management will happen on such a scale. Instead, reducing energy use will rely on deploying smart technologies and strategies in individual buildings. This is where most building owners should concentrate their efforts.

While analytics within an energy management system has multiple purposes, a key function involves managing energy usage. As analytics software and smart devices gather more data, this data becomes more detailed, allowing the software to examine and resolve increasingly complex problems. In a nutshell, the more data gathered on energy management, the more detailed the questions the energy management system can help answer. Energy management systems are going to expand beyond the metering and HVAC functions in traditional building systems. Environmental quality sensors will play a key role in this. Objective data about environmental conditions such as indoor air quality can guide the way you address health and safety issues while also helping you manage energy consumption. Occupancy sensors are already becoming a common way to regulate energy consumption based on how many people are using a space. An intelligent EMS can make real-time adjustments to building systems like HVAC and lighting in response to occupancy data. Active command and control of energy-consuming systems will become more important as businesses demand more flexible workspaces and consumer habits change. An intelligent EMS should allow you to control

building equipment more effectively and help reduce energy consumption during low traffic times while ensuring occupants have what they need when they need it.

Obstacles to Managing Energy in Intelligent Buildings

Three of the biggest obstacles for intelligent building energy management systems and how to overcome them include:

1. EMSs need to provide a certain degree of comfort to building occupants, as every person has a different idea about what a comfortable environment feels like. Creating a comfortable environment and increasing energy efficiency are often seen as conflicting goals, especially in commercial high-rise buildings. With the right EMS, though, building operators can implement strategies that help them achieve both priorities at the same time.
2. Intelligent building management systems are ideal for identifying systems and equipment that require preventive maintenance. However, without service contracts in place that can address small but necessary repairs, these can easily turn into much bigger problems. Some EMS providers offer their own service contracts connected directly with their software, so placing work requests and tracking resolutions can all be done from the same BMS you're using every day.
3. Competing interests between building owners and tenants, or even between different tenants, can make energy management more difficult. Generally, those paying the utility bills will seek energy-efficient solutions that lower costs while occupant businesses prioritize the comfort of employees and clients. The visibility you get from a comprehensive BMS with advanced energy management capabilities makes it easier to manage these competing priorities and even work toward making everyone happy at the same time. Understanding these obstacles and how to work around them will help stakeholders create better strategies for reducing energy use.

High Efficiency HVAC Equipment: Depending on your region, replacing heating and cooling equipment with higher efficiency equipment can reduce energy use by 50% for electric heating and cooling systems and 10% for gas furnace heating systems (U.S. Department of Energy see Compass guide). See the resources below for guidance on selecting and installing high performing equipment and designing effective energy efficiency programs around HVAC.

ENERGY STAR Certified Heating and Cooling Equipment*:* ENERGY STAR certified heating and cooling equipment, when properly installed, can yield annual energy bill savings of 10-30%. These products are independently certified to save energy without sacrificing features or functionality. Certified heating and cooling products include room air conditioners, central air conditioners, ductless heating and cooling, air-source heat pumps, furnaces, geothermal heat pumps, boilers, ventilation fans, smart thermostats, commercial boilers, and light commercial heating and cooling. Consider prioritizing ENERGY STAR certified heating and cooling equipment for higher energy savings.

Consortium for Energy Efficiency (CEE) Multitier Performance Specifications: The Consortium for Energy Efficiency's (CEE) multitier performance specifications are part of a broader effort to identify and encourage the purchase, installation, and maintenance of energy efficient residential central air conditioners, air source heat pumps, furnaces, and boilers. In order to achieve high in-field efficiency, realize savings, and overcome market barriers, CEE outlines three major elements: common efficiency specifications (multitier performance specifications), a quality installation specification, and promotion of quality maintenance. Efficiency programs can promote CEE multitier performance specifications to build demand for higher efficiency among consumers and to encourage manufacturers to design products to meet that demand.

Air-Source Heat Pumps in Cold Climates: The use of air-source heat pumps (ASHP) in cold climates has grown significantly in recent years; however, traditional sizing, selection and installation practices are not always well-suited to cold climates and have led to system inefficiencies and underperformance. To address this challenge, with support from DOE's Home Improvement Catalyst (HI Cat) Initiative, the Northeast Energy Efficiency Partnerships (NEEP) prepared two new resources: the Guide to Sizing & Selecting ASHPs in Cold Climates and the Guide to Installing ASHPs in Cold Climates. These guides provide clear guidance for ASHP installers to help ensure overall system performance and customer satisfaction.

ENERGY STAR Guidance on Duct Sealing: The ENERGY STAR Program offers technical and homeowner guidance to support duct sealing and repair. Up to 20% of conditioned air is lost while moving through a home's duct system because of air leakage, holes in ducts, and unconnected ducts. Sealed ductwork can reduce that loss and direct conditioned air to where it is needed.

High Performance HVAC Installation: Heating and cooling systems that are installed without verification of performance can result in as much as 30% higher energy use. The U.S. Department of Energy's Home Improvement Catalyst (HI Cat) Initiative is developing tools to support trades and program administrators in applying high performing HVAC installation practices.

HVAC Installation Practices: A Review of Research Findings: This systematic literature review documents and summarizes findings from available literature, research, and studies on better quantifying the benefits of improving current installation practices for the residential retrofit HVAC market.

Emerging Innovations in HVAC: The U.S. Department of Energy's Building Energy Research and Development program is working on new air conditioning technologies to significantly reduce energy use. Learn more about these 5 projects underway:

- Optimized Thermal Systems in Maryland is developing an advanced heat exchanger that minimizes joints by 90% compared to current models in order to reduce refrigerant

leakage. By minimizing the joints, the refrigerant stays where it should and does its job, working to keep homes cool and energy bills down.

- The University of Florida is developing a prototype that combines a water heater, dehumidifier, and air cooler, which could result in more efficient heat transfer. This technology provides enhanced dehumidification control in residential buildings, resulting in better comfort and significant energy savings.
- Dais Analytics in Florida, in partnership with Oak Ridge National Laboratory (ORNL), is developing a new membrane-based rooftop air conditioner, which would use water as a refrigerant instead of conventional chemicals. Not only is this technology well-aligned for sweltering, humid summer nights, but it could also save 30-50% in electrical consumption compared to today's roof top units.
- United Technologies Research Center in Connecticut is exploring electrocaloric, solid-state technology to develop a heat pump that will keep a space cool without using any chemical refrigerants. This technology is ideal for residential and small commercial buildings. It's small and quiet, and could result in 25% system efficiency improvement. With fewer mechanical parts, overall reliability could be improved—reducing the chances of air conditioning going out in the midst of a heat wave!
- Oak Ridge National Laboratory in Tennessee, in partnership with Georgia Tech and IntelliChoice Energy, is developing an energy storage system that integrates with HVAC units to reduce the overall energy requirements of air conditioning systems by utilizing waste heat that would otherwise be lost in traditional systems. Integrating ground-level diverse energy storage with HVAC could reach overall energy storage efficiency of 70% and improve HVAC performance by 35%.

CONCLUSIONS

In this paper, the application of different control algorithms was analyzed and discussed, in many different control perspectives. In fact, two main control categories have been investigated: classic (adaptive and rule-based control) and advanced (linear and nonlinear MPC). Several different applications of those control algorithms in smart grid and building levels were reviewed. The investigated studies show how to use different types of predictive control algorithms to optimize the flow of energy among different types of storages and users, while still preserving the demand, in particular in smart building applications. In this regard, the advantages and disadvantages of linear and nonlinear MPC algorithms were discussed. The studied application scenarios proved that, although a simple classic control (such as PID controllers) can be used for temperature control in buildings, more advanced algorithms.

REFERENCE

[1] N. Busch, D. Pooley, G. Faninger, Further tasks for future European energy R&D - Research and Innovation (European Commission), 2006.

[2] A. Martínez-Molina, I. Tort-Ausina, S. Cho, J.L. Vivancos, Energy efficiency and thermal comfort in historic buildings: A review, Renew. Sustain. Energy Rev. 61 (2016) 70–85.

[3] F. Pacheco-Torgal, Eco-efficient construction and building materials research under the EU Framework Programme Horizon 2020, Constr. Build. Mater. 51 (2014) 151–162.
[4] World Business Council for Sustainable Development, Energy efficiency in buildings: Transforming the market, (2009).
[5] Buildings Performance Institute Europe, Europe's Buildings under the Microscope. A country-bycountry review of the energy performance of buildnings., 2011.
[6] A. Costa, M.M. Keane, J.I. Torrens, E. Corry, Building operation and energy performance: Monitoring, analysis and optimisation toolkit, Appl. Energy. 101 (2013) 310–316. doi:10.1016/j.apenergy.2011.10.037.
[7] T. Weng, Y. Agarwal, From buildings to smart buildings-sensing and actuation to improve energy efficiency, IEEE Des. Test Comput. 29 (2012) 36–44. doi:10.1109/MDT.2012.2211855.
[8] L. Pérez-Lombard, J. Ortiz, C. Pout, A review on buildings energy consumption information, Energy Build. 40 (2008) 394–398. doi:10.1016/j.enbuild.2007.03.007.
[9] Directorate-General for Energy and Transport (European Commission), EU Energy and Transport in figures 2010, Statistical pocket book, 2010.
[10] Y. Agarwal, B. Balaji, S. Dutta, R.K. Gupta, T. Weng, Duty-Cycling Buildings Aggressively: The Next Frontier in HVAC Control Categories and Subject Descriptors, in: Inf. Process. Sens. Networks (IPSN), 2011 10th Int. Conf., 2011: pp. 246–257.
[11] T. Kalamees, K. Jylhä, H. Tietäväinen, J. Jokisalo, S. Ilomets, R. Hyvönen, S. Saku, Development of weighting factors for climate variables for selecting the energy reference year according to then ISO 15927-4 standard, Energy Build. 47 (2012) 53–60. doi:10.1016/j.enbuild.2011.11.031.
[12] B. Sun, P.B. Luh, Q.S. Jia, Z. Jiang, F. Wang, C. Song, Building energy management: Integrated control of active and passive heating, cooling, lighting, shading, and ventilation systems, IEEE Trans. Autom. Sci. Eng. 10 (2013) 588–602. doi:10.1109/TASE.2012.2205567.
[13] D. Wijayasekara, O. Linda, M. Manic, C. Rieger, Mining building energy management system data using fuzzy anomaly detection and linguistic descriptions, IEEE Trans. Ind. Informatics. 10 (2014) 1829–1840. doi:10.1109/TII.2014.2328291.
[14] P. Palensky, D. Dietrich, Demand side management: Demand response, intelligent energy systems, and smart loads, IEEE Trans. Ind. Informatics. 7 (2011) 381–388. doi:10.1109/TII.2011.2158841.
[15] G.T. Costanzo, G. Zhu, M.F. Anjos, G. Savard, A system architecture for autonomous demand side load management in smart buildings, IEEE Trans. Smart Grid. 3 (2012) 2157–2165. doi:10.1109/TSG.2012.221735.

CHAPTER-4.4

ENERGY-EFFICIENT STRUCTURES

Deepak Singh Bisht[1], Dr. Bharat V.P.S. Rawat[2]
[1]Assistant Professor, Department of Mechanical Engineering, J.B. Institute of Technology, Dehradun, (UK)
[2]Associate Professor, Department of Mechanical Engineering, J.B. Institute of Technology, Dehradun, (UK)

ABSTRACT- *About 35% of all energy usage is accounted for by the construction industry. Realizing the situation, it is now necessary to implement a sustainable green building design method, which is the best way to lower the building's energy requirements. Overuse of traditional building materials has an impact on natural resources in addition to contributing to global warming. In comparison to traditionally constructed buildings, green or sustainable structures use vital resources like electricity, water, materials, and land more effectively. For both newly built and existing buildings, research has been conducted to evaluate their potential and ability to save energy. The paper discusses numerous energy-saving ideas that can be used to increase building energy efficiency while keeping costs in mind during the planning, designing, building, and implementation stages. Incorporating different energy-saving criteria, some green buildings have been conceptualized and modelled using the Autodesk Revit programme. In order to determine the energy efficiency of these structures and to determine the best course of action, Autodesk Green Building Studio is used.*

Keywords: Green Buildings, LEED-India, Autodesk Revit, Autodesk Green Building Studio.

INTRODUCTION

The building sector has recently placed a greater emphasis on sustainability. Buildings are now being built more sustainably and efficiently by consuming less energy and spending less on maintenance and upkeep. Preserving the structure. A green building is the result of a design philosophy that emphasizes improving resource use efficiency, including the use of energy, water, and materials, while reducing the impact on human health and the environment during the building's lifecycle.

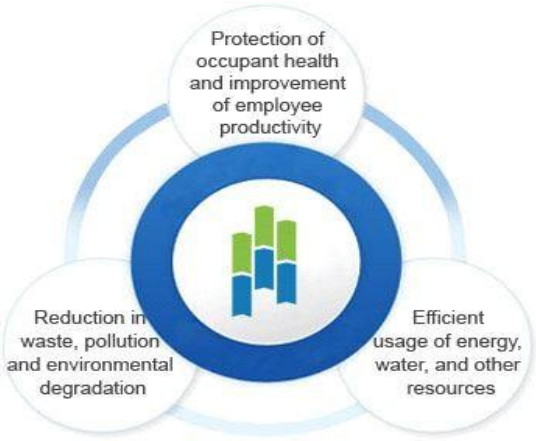


Figure 1: Green Building Design Concept.

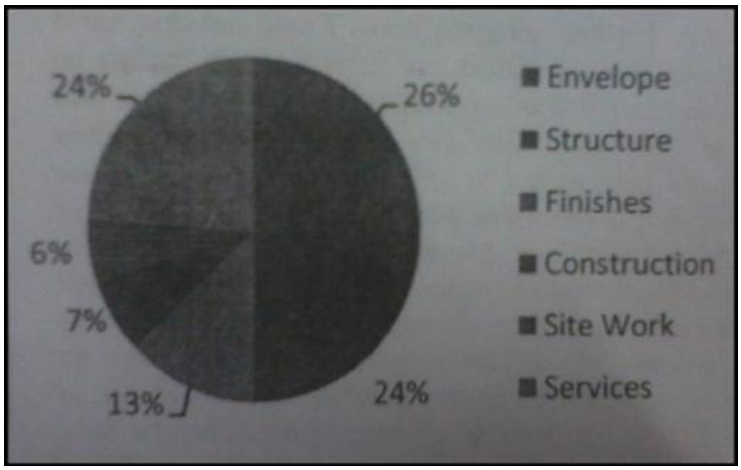
Many developers use environmentally friendly innovative technologies like energy-efficient materials, smart devices, energy-efficient doors and windows, solar water heating and generating power, rain water harvesting, and more throughout the country. However, more

and more builders and developers are now choosing to work on projects that support an eco-friendly way of life.

Energy Efficient Construction

Necessity of Energy Efficient Construction

The increasing power usage in the real estate sector is accelerating the need for energy efficient building. Today's construction and use of buildings results in excessive energy consumption for lighting and heating/cooling. The building sector has a potential for energy savings of between 30 and 40%, which will not only ease the strain on the power sector to satisfy demand but also assist residents in lowering their energy costs (ECBC, 2007).



***Source*: Journal of Indian Building Congress, 2010**

Figure 2: Percentage of energy Consumption by various components of building.

LEED- India

A nationally and internationally recognised standard for the design, constructing, and operation of high-performance green buildings is the leadership in energy and environmental design (LEED-INDIA) Green constructing rating system. By recognising achievement in the following five essential areas: Sustainable site development, Water Savings, Energy efficiency, Materials selection, and Indoor environment quality, LEED-INDIA encourages a total building approach to sustainability**.**

Numerous Energy Saving Ideas

• Site Selection – Although choosing a site is typically oriented on cost, a bad choice may exclude a number of sustainable aspects. A high-performance building can be differentiated from a conventional one by maximizing the site's potential.

• Orientation – The right orientation promotes day lighting and passive solar gain. South-facing windows receive the most sunlight in the northern hemisphere. Because of the low angle of the setting, windows facing west need to be carefully built to prevent overheating.

• Walls and Roof – A major factor in determining how much energy is needed to heat and cool a structure is its envelope. The difficulty lies in minimizing conductive heat loss/gain

while minimizing uncontrolled air flow into the building while constructing the foundation, walls, and roofs.

• Energy Efficient Appliances – Using eco-friendly and energy-efficient appliances lowers utility costs. Always look for the BEE star rating when buying new electrical items. More stars denote greater effectiveness. The savings and the comfort of the occupants will more than make up for the slight initial installation cost increase.

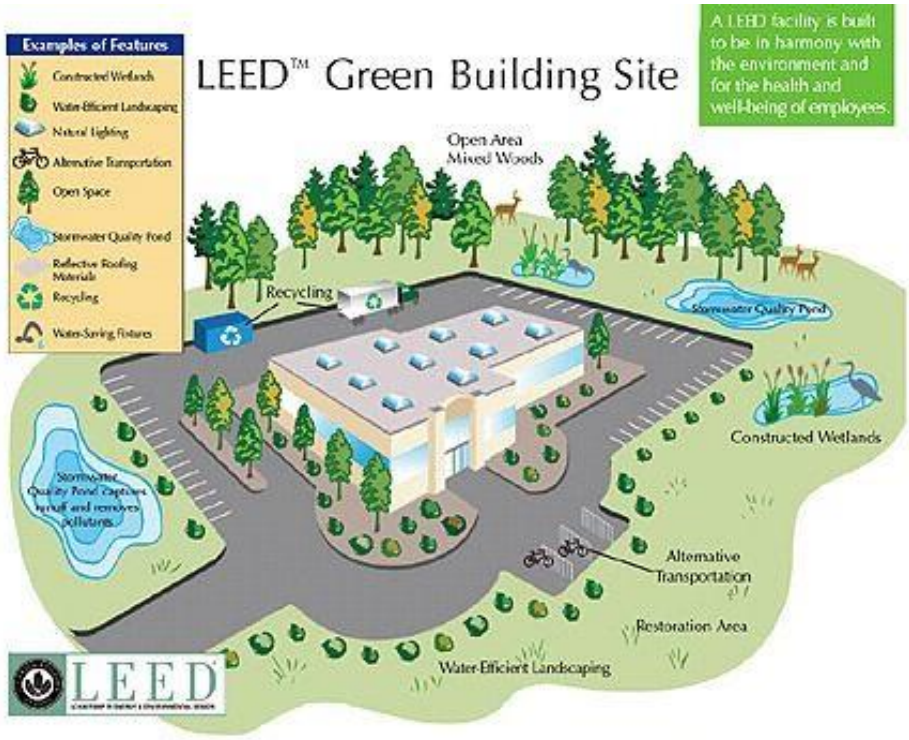


Figure 3: Green Building Site.

- Heating, Air-Conditioning, and Ventilation - By lowering the structure's heat load, a smaller heating and cooling system can be installed. A crucial factor in green building, high-quality ventilation systems are frequently disregarded during the design stage.
- Waste minimization – Green design also aims to minimise material, water, and energy waste during building. Reduce the amount of waste going to landfills as one objective. By providing on-site solutions like compost bins to lessen the amount of garbage going to landfills, well-designed buildings also assist in reducing the quantity of waste generated by inhabitants.

Financial Efficiency

A green building is more expensive than a traditional construction by 3-8%. But through maintenance cost savings, the expense is recouped in two to three years. The total cost of ownership of a green building is invariably lower than that of a conventional building due to the significant reduction in operational expenditures. ECBC's recommendations for lightning, efficient systems, and envelopes account for the greatest cost increase. There won't be any further charges once ECBC is required. Additionally, according to an analysis (Source:

TERI-GRIHA), the Life Cycle Cost of energy-efficient buildings is lower than that of conventional buildings.

Energy Modelling for Building Performance

Plans, elevations, sections, and other two-dimensional drawings were frequently used in traditional building design. Building information modelling goes beyond 3D by adding time as a fourth dimension and cost as a fifth to the three main spatial dimensions of width, height, and depth. As a result, BIM goes beyond geometry. Additionally, it contains geographic information, spatial correlations, light analysis, and the amounts and characteristics of construction materials.

Designed exclusively for Building Information Modelling (BIM), Autodesk Revit® software enables design and construction professionals to take ideas from conception to completion using a coordinated and model-based methodology. Revit is a single programme that offers capabilities for structural and MEP engineering, architectural design, and building work. It enables 3D modelling of a structure's parts and annotating them.

Construction of an analytical energy model

Model development for energy simulation. It can generate power. Analytical models can be created manually using conceptual massing or immediately from architectural building elements and room/space elements to fit varied design stage needs, workflows and precision preferences.

Whole building Energy Analysis

The use of conceptual energy analysis tools improves the sustainability of every design. It may be beneficial to show analytical results in a highly visual style for straightforward comparison and interpretation. Additionally, the tools can be utilised directly within the Autodesk Revit Architecture software to analyse the energy usage and lifecycle costs of design alternatives.

Run building performance simulations to maximise energy efficiency and move towards carbon neutrality earlier in the design phase using Autodesk® Green Building Studio, a configurable cloud-based tool. Web services offered by Autodesk Green Building Studio include: Peak electric energy demand (kW), annual energy consumption (electric and gas), lifecycle energy consumption (electric and gas), on-site energy generation from solar and wind systems, and lifecycle energy expenses (30 years).

Conclusion

One of the main economic activity in India is the construction industry. As the business expands quickly, protecting the environment brings many difficulties as well as opportunities for many people working in it. The design and maintenance of a healthy, resource-efficient constructed environment based on ecological principles is known as sustainable construction. It places a strong emphasis on waste minimization, environmental conservation, and resource

efficiency. One of the easiest, quickest, most affordable, and cleanest methods to address energy and environmental concerns is through energy efficiency. Energy consumption can be significantly decreased by including easy energy-saving measures in buildings. The necessary knowledge and technology are available to design energy-efficient and environmentally friendly buildings, but obstacles in behavior, organizations, and finances still need to be removed.

REFERENCES

[1] ECBC 2007 User guide published by Bureau of Energy Efficiency
[2] The Energy Conservation Act-2001
[3] Journal of the Indian Building Congress, 2010
[4] Bureau of Indian Standards 2005, New Delhi
[5] National Building Code of India 2005, New Delhi
[6] www.grihaindia.org
[7] www.mnre.gov.in
[8] www.igbc.in
[9] www.glassisgreen.com/Leed-India-green-certification
[10] www.wikipedia.org
[11] www.autodesk.in
[12] www.sustainableresearchgroup.com

CHAPTER-4.5

LPG GAS SPILLAGE DISCOVERY UTILIZING ARDUINO

Punit Kumar[1], Dr. Bharat VPS Rawat[2]
[1]*Associate Professor, Department of Mechanical Engineering,* JB Institute of Technology, Dehradun
[2]*Associate Professor, JB Institute of Technology, Dehradun, Uttrakhand, India*

Abstract- *Spilling of gas is the serious issue with modern area, homegrown regions and vehicles run by CNG gas. Because of spillage of LPG gas, it produces unsafe and poisonous effect for living things. LPG and petroleum gas is exceptionally flammable and can consume even at some separation from the wellspring of outpouring. One of the preventive measures to stop the blast and risk is to introduce the spillage discovery unit. The principal point of this paper is to introduce the identification of spillage, alert the risk to individuals and kill the gas to keep from blast. The gas will be distinguished by utilizing MQ6 gas sensor. It will promptly turn on the LEDs, bell and LCD shows message to alarm the greatest number individuals. The framework incorporates a GSM module which makes the proprietor to tell the risk. It will likewise turn on the programmed opening of the window and fumes fan to send the gas out and kill the fixation. These frameworks are constrained by Arduino stage.*

INTRODUCTION

Gaseous petrol has been the most fundamental need non-sustainable assets. Humanity is over-taking advantage of this asset in basic sums. Parts of propane, butane, propylene, butylene, isobutane and combination of hydrocarbon gases consolidate to shape LPG gas which is exceptionally inflammable. LPG gas is scentless by its property which expanding the gamble by not being identified with regards to smell. A serious issue because of gas spill is impacts blasts and mishaps. It has various modern and homegrown utilizations since past many years, in the event that a hole happens and assuming that gas meets a little wellspring of start, enormous harm can take place. Gas spillage security structure becomes extremely valuable and beneficial to protect from additional gas release hardships. Security assumes a significant part in today's world and essential could wellbeing frameworks are to be executed.

LPG Gas leakage detection using Arduino

In the world of LPG gas users, the gas leakage problems and accidents are increasing drastically. Whenever the spillage of LPG gas occurs, the gas sensor is used to detect the leakage of gas. The Arduino will alert the buzzer, LEDs, LCD display. It sends the SMS alert through GSM module.

Proposed System

In the proposed system of "LPG Gas Leakage Detection using Arduino" will be great help in preventing explosions and blasts. Apart from sound alarm and SMS alert it will also turn on exhaust fan and automatic opening of window by the mechanical force using servo motor.

This helps to remove the leaked gas inroom, which is used in case of nobody is present when the leakage occurs and to prevent accidents and property.

Block diagram

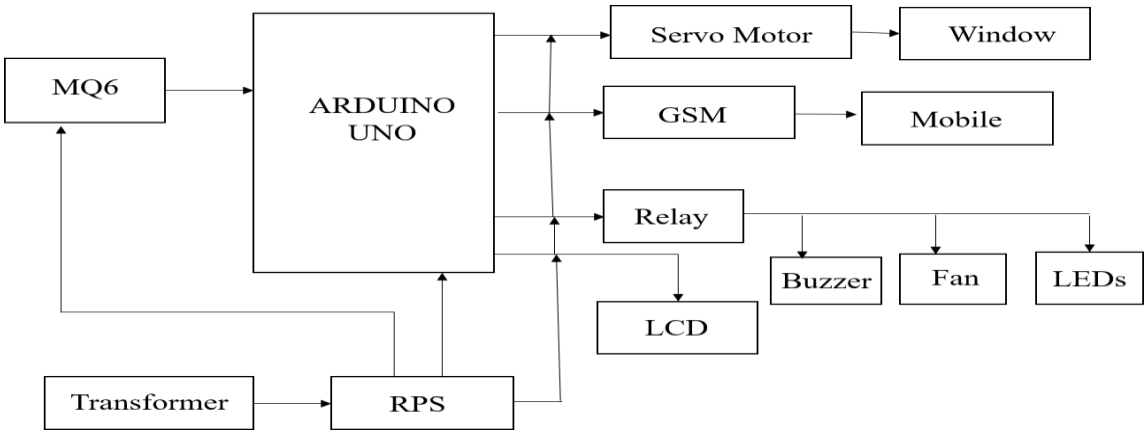


Fig:1 Block diagram of Proposed System

The way this instrument works is when gas is detected by gas sensor as indicated by the LPG gas level it distinguishes. The higher the LPG gas is distinguished, the higher the voltage delivered. At the point when the sensor yield is moved the presence of gas, then Arduino will endlessly enact the bell and show the composition on the LCD expressing the gas is high, and that implies there has been a gas release, then, at that point, the GSM SIM800L module will send notification message to the hand phone number determined in the program.

Nonetheless, on the off chance that the sensor doesn't distinguish a release, the sensor won't eliminate the result, and the sensor will keep on working until it is demonstrated that there is a LPG gas spill. At the point when the program is run the framework will promptly recognize LPG gas identified by the sensor. Then, at that point, the Arduino microcontroller will peruse LPG gas through a LPG gas sensor. In the event that it recognizes a gas release, the red Drove will illuminate, the bell will enact, the window will open naturally by usage of servo engine, and furthermore running of fumes fan to kill the spillage, then, at that point, the framework will send a notice message expressing that there has been a LPG gas spill. In the wake of tackling the issue of location, the green Drove will sparkle, which shows there could be no further difficulty. Assuming that no LPG gas spill is identified, the framework will keep on recognizing the gas level through the LPG gas sensor until it distinguishes a LPG gas spill.

HARDWARE DESCRIPTION

Arduino Uno

The Uno with Link is a miniature regulator board base on the ATmega328. It has 14 computerized input/yield pins (of which 6 can be utilized as PWM yields); 6-simple data sources, a 16 MHz fired resonator, a USB association, a power jack, an ICSP header, and a reset button. It contains everything need to help the microcontroller; essentially interface it to a PC with a USB link or power it with an air conditioner to-DC connector or battery to begin.

"Uno" signifies one in Italian and is the name to check the impending arrival of Arduino 1.0. The Uno and adaptation 1.0 will be the reference forms of Arduino, pushing ahead. The Uno is the most recent in a progression of USB Arduino sheets and the reference model for the Arduino stage; for an examination with past renditions, see the list of Arduino sheets. Note: The Uno R3 reference configuration can utilize an Atmega8,168, or 328, Current models utilize an Atmega328, yet an Atmega8 is displayed in the schematic for reference. The pin design is in distinguishable on every one of the three processors.

Fig:2 Arduino Uno

MQ Sensor

The MQ-6 sensor is fit for recognizing a great many gases including carbon monoxide, liquor, methane, hydrogen, isobutene, condensed oil gas, propane, and smoke in the scope of 200-10,000 ppm. For the simple communicating, the MQ-6 sensor Module is furnished with 4 male headers so it very well may be effectively connected with the Arduino Uno or Super utilizing male to female kind jumper wires. MQ-6 SENSOR PINOUT. As you can see the 4 male header pins are marked with A_0, D_0, GND and Vcc.

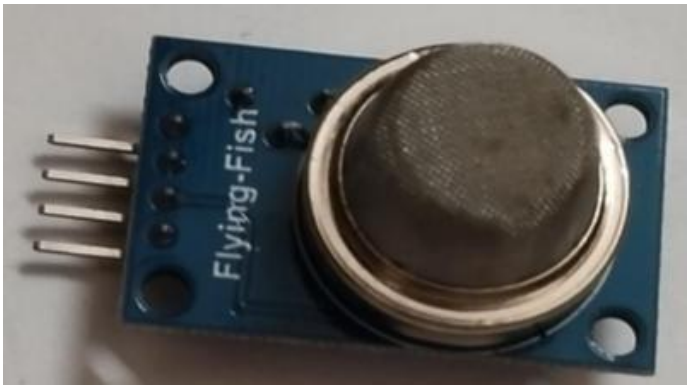


Fig:3 MQ Sensor

GSM Module

SIM800L GSM module is utilized to send SMS cautioning on gas recognition. GSM is implied as a gadget utilized for trading the data. SIM card is recuperated from the GSM to control the remote hub 5 volts of the DC supply is expected by the GSM for working. The modem needs just three association (transmitter, collector, ground) to communicate with

Arduino regulator Atmega-328 the abundance power supply is utilized. Arduino microcontroller is connected with the collector pin to the gadget. The Arduino give data to the GSM gadget. The GSM will send a result to through the SIM embedded into its SIM opening to number composed into the code to alarm about the spillage of the LPG gas or different gas detected by the sensor.

Fig:4 SIM800L GSM Module

Buzzer

The signal will be utilized to produce sounds to caution clients during spillage. A bell or beeper is a flagging gadget normally hardware, that is most regularly comprises of various switches or sensors associated with a control unit that decides whether and which button was pushed or a pre-set time has passed, and as a rule enlightens a light on the fitting button or control board, and sounds an admonition as a persistent or discontinuous humming or blaring sound. At first this gadget depended on an electromechanical framework which was indistinguishable from an electric chime without the metal gong.

Fig:5 Buzzer

LCD (Liquid Crystal Display)

LCD is utilized for showing the message demonstrating that "gas identified at zone" into the presentation, which is at first coded in program to show the peril. The message been shown on the LCD, information and order both are register of LCD and it's displayed in fig.5. The register chooses is utilized to adjust the registers. Information register RS=1, while for the order register RS=0 is utilized.

Fig:6 LCD display

Exhaust Fan

The exhaust fan gets operated when the gas sensor detects the gas. It is used to send the leaked gas of some part out of the room. Hence, it is helpful in preventing from further explosion.

Fig:7 Exhaust Fan

Servo Motor

A servo engine is a sort of engine that can turn with extraordinary accuracy. Typically this kind of engine comprises of a control circuit that gives criticism on the ongoing place of the engine shaft, this input permits the servo engines to pivot with extraordinary accuracy. To turn an item at a few explicit points or distance, then you utilize a servo engine. It is comprised of a basic engine which goes through a servo component. On the off chance that engine is controlled by a DC power supply, it is called DC servo engine, and on the off chance that it is AC-fueled engine, it is called AC servo motor. A servo engine for the most part accompanies a stuff plan that permits us to get an exceptionally high force servo engine in little and lightweight bundles. Because of these highlights, they are being utilized in numerous applications like toy vehicle, RC helicopters and planes, advanced mechanics, and so on.

Fig:8 Servo Motor

RELAY

A relay is an electrically operated switch. It consists of a set of input terminals for a single or multiple control signals, and a set of operating contact terminals. The switch may have any number of contacts in multiple contact forms, such as make contacts in multiple contact forms, such as make contacts, break contacts, or combination.

Fig:9 1-Channel Relay

RESULT

The device was tested placing the LPG device at leaked area. We obtained the results as expected since the system was built as expected according to plan. After gas is sensed the red LED glows, buzzer sounds, LCD displays message, GSM sends notification to users then exhaust fan runs and opens the window to neutralize. After there is no gas leak, every components stops a triggering and green LED glows indicating no threat.

CONCLUSION

Subsequent to going through this task overview, it can presume that recognition of the LPG gas spillage is unbelievable in the venture framework. Also, it is important to give the gas spillage assurance framework for different applications like modern and homegrown clients in day to day existence. In peril circumstances we can save the life by utilizing this framework. An alarm is demonstrated by the GSM module. A sensor hub detects gas like CO_2, oxygen, propane. The assessed scope of transmission and utilization of force is acquired. The basic methods and Arduino UNO Miniature regulator region used to assemble

the sensor.

In future, this gadget can be contacted different areas and has adequate conceivable outcomes to stick out. The sensor can be used to be known about more unique assortment of gas spillage. When told they can battle the issue and prevent any further mishaps from occurring. This might yield productive outcome in handling such Furthermore we additionally anticipate making it versatile, with the goal that the clients can convey it anyplace and utilize this gadget. By utilizing a high level GSM innovation or Raspberry PI, we intend to implant the close by area of the fire administration naturally into the framework through the Web any place it is taken by the client. With the goal that the gadget after identifying the new area can naturally match up the subtleties of the nearby specialists into it which might be in general more successful; ideally, mishaps anyplace can undoubtedly be halted through this gadget now. Taking into account every one of the possibilities, we can bring this gadget besides into the poultry ranches as our gadget is intended to battle gas spillage in for the most part shut places.

REFERENCES

[1] Hussain A. Attia, Halah Y. Ali, ”Electronic Design of Liquefied Petroleum GasLeakage Monitoring, Alarm, and Protection Based System Based on Discrete Components”, International Journalof Applied Engineering Research ISSN 0973-4562 Vol.No. 11.

[2] Nivedhitha S,Padmavathy A P,Susaritha U S, “ Development of Multipurpose Gas Leakage and Fire Detector with Alarm system”, 2013 Texas Instruments India Educator‟Conference.

[3] E. JebamalarLeavline, D. Asir Antony Gnana Singh, B. Abinaya H. Deepika, “LPG Gas Leakage Detection and Alert System”,International Journal of Eletronics Engineering Research, ISSN 0975-6450 Vol.No. 9.

[4] Ankit Sood,Bablu Sonkar, Atul Ranjan, Ameer Faisal, “Microcontroller Based LPG Gas Leakage Detector using GSM Module, International Journalof Electrical and Electronics Research, Vol.3, Issue.2, pp: (264-269), Month: April-June 2015.

[5] Alan M John, Bhavesh Purbia, Ankit Sharma, Mrs. A. S. Udapurkar. “LPG/CNG Gas Leakage Dectection System with GSM and Communication Engineering, Vol.No. 6, Issue 5, May 2017.

CHAPTER-4.6

The Exploration of Shortcoming Finding of Thermal energy station in light of ELM-AdaBoost-SAMME

Manik Pal Shah[1], Dr. Bharat VPS Rawat[2]
[1]Assistant Professor, JB Institute of Technology, Dehradun, 248197, India
[2]Associate Professor, JB Institute of Technology, Dehradun, 248197, India

ABSTRACT-*A shortcoming finding structure in light of outrageous learning machine (ELM) and AdaBoost.SAMME is proposed in a thermal energy station (NPP) in this paper. After briefly depicting the standards of ELM and AdaBoost.SAMME calculation, the shortcoming determination structure sets ELM calculation as the frail classifier and afterward coordinates a few feeble classifiers into a solid one utilizing the AdaBoost.SAMME calculation. Besides, a few trials are advanced for the setting of two calculations. The after-effects of simulation investigates the HPR1000 test system show that the joined strategy has higher accuracy and quicker speed by working on the presentation of feeble classifiers contrasted with the BP brain organization and confirm the achievability and legitimacy of the group learning technique for shortcoming finding. In the mean time, the outcomes likewise demonstrate that the proposed technique can meet the necessities of a constant determination of the thermal energy station.*

INTRODUCTION-

Designs of the thermal energy station (NPP) are confounded, which have potential radiation impediment. Subsequently, the prerequisites for their security and unwavering quality are very severe. One specialized method for giving activity supports to the administrators is shortcoming determination innovation, and its application in NPP can help administrators to find and distinguish blames ideal and precisely. It is additionally a compelling technique for forestalling and decreasing human element blunders. Issue determination innovation has significant importance in working on the protected activity of NPP [1].

With the wide use of advanced instruments and control frameworks in NPP, the issue analysis strategies in light of information driving have gotten broad examination. In the writing, a great deal of shortcoming finding techniques have been proposed; for instance, Wang Hang applied the help vector machine (SVM) and further developed molecule swarm enhancement (PSO) to perform further conclusion in NPP based on subjective thinking by information based primer determination and test information given by a web-based reenactment model [2]. Sinuhe embraced a period slacked feed-forward brain network in the examination of the complete quick blockage of a get together in the center of a sodium-cooled quick reactor [3]. Head part examination (PCA) is applied for shortcoming location of sensors in a thermal energy station by Li et al. [4]. Qiu Pinda tended to a plan for working on the exactness of shortcoming conclusion by melding the scanty coding issue finding results with the master framework [5]. Shyamapada Mandal tended to a methodology for little/minor shortcoming location of thermocouple sensors in a thermal energy station utilizing time series examination techniques [6]. He proposed one more technique in light of the emblematic unique channel (SDF); the proposed strategy is likewise ready to identify and order the minor

as well as significant sign deficiencies in the thermocouple signal [6].

To deal with the perplexing sensor blunder recognition issue in NPPs, a LSTM network was applied with successes acquired by Choi and Lee [7]. The above techniques have made a few accomplishments in shortcoming conclusion of NPP, yet they have their downsides: brain network in view of slope dive strategy is inclined to get the nearby least with slow union and propensity to over fitting [8]; SVM needs scantiness, and with the rising example size, the quantity of help vector will in general increment with time spent in model preparation [9]. PCA is applied to blame recognition based on consistent circumstances, yet for the variable states of NPP, a solitary PCA model is challenging to apply in light of the fact that it might cause misdiagnosis and missed finding [10, 11]. Master frameworks require a lot of master experience which is frequently difficult to get [12]. SDF is basically a sort of time series examination technique, and the essential thought of SDF is utilizing transient connection of verifiable information to anticipate conduct; in this way, SDF has better exhibitions for solid time grouping information, however with restricted capacities for information with a great deal of nonlinear connection. LSTM is hard to decide boundaries, so it is challenging to be practice applied [13].

Albeit a ton of techniques have been finished on issue determination in NPP, most applications center solely around the plan and streamlining of every strategy as well as the execution of every strategy on different frameworks or parts. That is, various calculations have various exhibitions, benefits, and detriments. Fulfilling every one of the necessities in NPP with a solitary algorithm can be truly troublesome.

The most effective method to work on the exhibition of every calculation has turned into the exploration focal point of numerous researchers. Luckily, the development of troupe learning can give thoughts to taking care of those issues; however there is little examination on the shortcoming determination with a gathering learning calculation in NPP. The model that meets the preparation tests might not have a similar decent presentation in commonsense application, so the model will be presented to a specific measure of hazard while being yield. It is truly worth focusing on that the combination of numerous models can diminish this gamble. Troupe learning can join various powerless models to a decent solid model. With the expanding of the quantity of powerless models, the mistake pace of the incorporation diminishes dramatically and at last goes to zero [14, 15]. Furthermore, gathering learning can likewise incredibly work on the steadiness and speculation capacity of unique feeble models [16].

In this paper, as a delegate calculation of outfit learning, the AdaBoost calculation joined with the SAMME calculation (with sage wise added substance demonstrating utilizing a multiclass remarkable misfortune capability) [17] is applied in shortcoming determination research in NPP, which choosing outrageous learning machine (ELM) as the frail classifier. The commitments of this paper are as per the following:

(I) A shortcoming conclusion strategy in light of ELM-Ada-Boost.SAMME for the thermal

energy station is proposed.

(ii) AdaBoost.SAMME is applied to work on the presentation of the ELM calculation.

(iii) The clever piece of this work is to check the plausibility and legitimacy of the gathering learning strategy for shortcoming conclusion in this paper. The paper is coordinated as follows: in light of past exploration, advancement points of this paper are portrayed in Area 1. Two distinct techniques are acquainted with incorporate into Segment 2. Segment 3 layouts the issue conclusion structure in NPP with a gathering learning calculation. The precision and adequacy of the group learning calculation are assessed in the HPR1000 test system in Segment 4. Ends are given in the last segment.

Plan of Issue Finding Technique for NPP In view of ELM-AdaBoost.SAMME: Trademark Boundary Determination for Shortcoming Analysis: Accepting HPR1000 NPP for instance, the examination and investigations depend on the HPR1000 test system. The normal deficiencies of NPP chose for exploratory confirmation are loss of coolant mishap (LOCA), steam generator tube crack (SGTR), fundamental steam pipe break in the control, and primary steam pipe burst external the regulation. These issues are common mishaps that might annihilate the honesty of NPP. On the off chance that any mishap happens, NPP would without a doubt be in a very risky state, and the administrators may scarcely pass judgment on the issue and take countermeasures rapidly. The outcomes would be incredible whenever misused. Through dissecting the explanations behind the mishaps occurred, 21 shortcoming side effects are chosen for and explained in the accompanying passage: The temperature inside the control; regulation sump level; pressurizer water level; no. 2 SG steam stream; coolant stream in circle 1; coolant stream in circle 3; no. 1 SG steam pressure; no. 3 SG steam pressure; temperature of the hot leg in circle 2; temperature of the cool leg in circle 1; temperature of the chilly leg in circle 3; tension inside the regulation; pressurizer pressure; no. 1 SG steam stream; no. 3 SG steam stream; coolant stream in circle 2; essential normal tension; no. 2 SG steam pressure; temperature of the hot leg in circle 1; temperature of the hot leg in circle 3; and temperature of the cool leg in circle 2.

System for NPP Issue Finding In light of ELMAdaBoost. SAMME: The essence of shortcoming finding for NPP is a multi classification issue, a mix of ELM and AdaBoost.SAMME can settle the issue well. ELM comprises of three layers, the 21 trademark boundaries presented by the prior words are picked as the example contributions of ELM. Because of countless information boundaries and preparing tests, the quantity of secret layers is 140 which is concluded by the recreation tests in the accompanying area. Four common flaws encoding are picked as the result of ELM.

Calculation stream in light of the ELM-AdaBoost.SAMME is summed up in Figure 2. The left of the structure is the AdaBoost.SAMME calculation; close to it is the ELM calculation. During each pass in the know, the AdaBoost.SAMME calculation is called to produce a powerless classifier applying ELM calculation. Subsequent to preparing the classifier with the entire examples, blunders of the classifier are acquired and saved. The mistakes are

utilized to ascertain the weight values which will conclude the classifiers' portion in the last classifier and update tests' weight values. AdaBoost.SAMME calculation will stop naturally after the foreordained numbers are reached. Consolidating the entire classifiers, we can get the last result encoding as the aftereffect of issue analysis.

Simulation Tests and Examination: In this part, the conclusion model is prepared and tried with exploratory information to check its capacity of shortcoming acknowledgment. In the mean time, to test the model presentation on each angle, BP brain network has been laid out for examination.

Settings for ELM. A superior enactment capability for ELM will make a commitment to the more exact recognition of an issue that happened in NPP. Three enactment capabilities are picked. Sin capability's mistake rate has been reliably high inside the scope of 100 secret layers of ELM. Hardlim capability is a lot of something similar with the sigmoid, however the bend of the blunder pace of the sigmoid capability is steadier and with the littlest mistake rate which addresses the most elevated precision, comparative with different capabilities. In this manner, the sigmoid capability is chosen as the enactment capability for the ELM calculation.

The quantity of secret neurons of the ELM calculation is significant to the presentation and precision of the organization, as well as limiting the preparation time. Toward the start of the preparation, the quantity of secret neurons is 10, and afterward it progressively increments to 300 with a stage of 10. At long last, the mistake rate bends of the preparation tests and the test tests with the various quantities of secret neurons are displayed and the bend of preparing time is displayed. It very well may be seen that the blunder rate will in general diminish amazingly with the rising number of stowed away neurons, whether to the preparation bend or testing bend. In addition, the precision of preparing tests is roughly keeping at 90%, when the quantity of secret neurons arrives at 100. The preparation time increments marginally with the quantity of secret neurons and fundamentally keeps up with at 1.76 s.

To check the helping impact of the ELM-Ada-Boost.SAMME technique, the accompanying simulation tries different things with the various quantities of powerless classifiers are completed. The three bends address exhibitions of ELM with the various quantities of secret layers: 140, 230, and 400. 140 is set as the quantity of secret layers for a powerless classifier, 230 addresses a somewhat more grounded feeble classifier, and the most grounded frail classifier has 400 secret layers. The outcome shows that the ELM with 140 secret layers has the greatest leap with a 4.45% advancement of exactness rate. The most grounded powerless classifier has the least blunder rate all along; notwithstanding, it has insufficient space for higher precision as a result of taking up a lot of PC assets. Accordingly, to check calculations' legitimacy, there is compelling reason need to choose the model with the littlest mistake rate. In a word, to exhibit a more articulated impact, the quantity of secret neurons is chosen as 140 with lower preparing exactness of 89.25% in this paper.

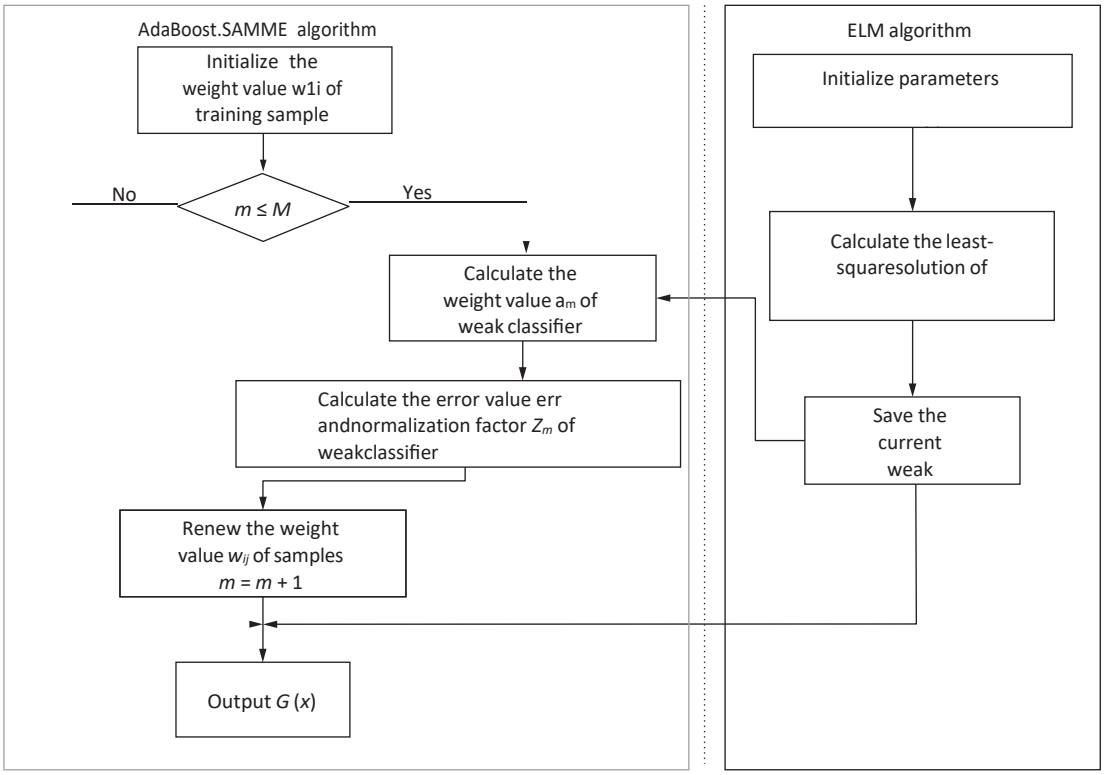


Figure 1 The system of shortcoming analysis in view of ELM-AdaBoost.SAMME.

With the previous examination, we can presume that the ELM-AdaBoost.SAMME model can analyze the breakdown all the more rapidly and dependably. Consequently, the Ada-Boost.SAMME calculation truly has some exactness upgrades for feeble classifiers. Simultaneously, it is demonstrated that the ELM-AdaBoost.SAMME model can likewise meet the constant prerequisite.

Conclusion-

In this paper, an ELM-AdaBoost.SAMME-based strategy is applied for shortcoming determination in NPP. The ELM-Ada-Boost.SAMME model chooses the ELM calculation as its frail classifiers and afterward applies the AdaBoost.SAMME calculation to coordinate powerless classifiers into a solid classifier. To gauge the shortcoming

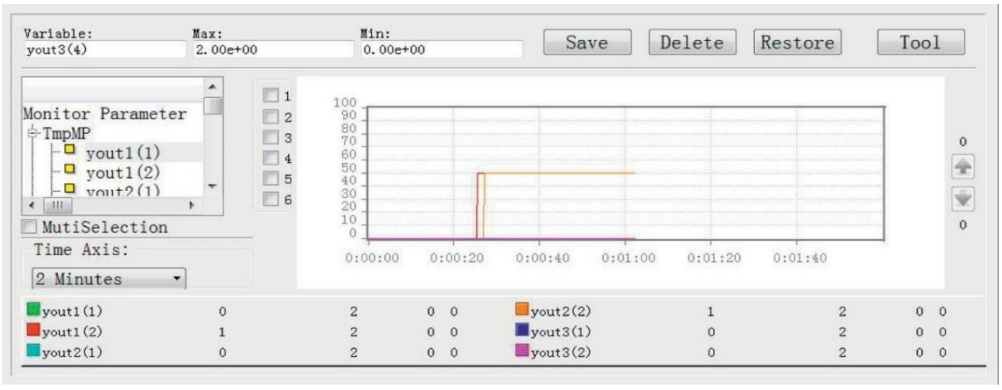


Figure 2 Comparison curves of an online test of the two models.

conclusion capacity of the proposed model for NPP, a determination model in light of ELM-

AdaBoost.SAMME is fabricated. Furthermore, the model incorporates into the HPR1000 test system for ongoing testing and a more precise reflection. Simulation results show that the model is portrayed by the quick and precise finding as well as ongoing prerequisite.

In the mean time, the AdaBoost.SAMME calculation is additionally ended up being compelling in helping the feeble classifier. That is, the AdaBoost.SAMME calculation can be applied in the ELM calculation as well as in other conclusion calculations.

REFERENCES

[1] Y. Yao, J. Wang, M. Xie, L. Hu, and J. Wang, "A new approach for fault diagnosis with full-scope simulator based on state information imaging in nuclear power plant," *Annals of Nuclear Energy*, vol. 141, 2020.

[2] H. Wang, M.-J. Peng, J. Wesley Hines, G.-Y. Zheng, Y.-K. Liu, and R. Upadhyaya Belle, "A hybrid fault diagnosis method- ology with support vector machine and improved particle swarm optimization for nuclear power plants," *ISA Trans- actions*, vol. 95, 2019.

[3] S. Martinez-Martinez, N. Messai, J.-P. Jeannot, and D. Nuzillard, "Two neural network based strategies for the detection of a total instantaneous blockage of a sodium-cooled fast reactor," *Reliability Engineering and System Safety*, vol. 137, 2015.

[4] W. Li, M.-J. Peng, and Q.-Z. Wang, "False alarm reducing in PCA method for sensor fault detection in a nuclear power plant," *Annals of Nuclear Energy*, vol. 118, 2018.

[5] P. Qiu and L. Ye, "Research on fault diagnosis method of coolant system in nuclear power plant," in *Proceedings of 2019 3rd International Conference on Artificial intelligence,Sys- tems,and Computing Technology (AISCT 2019)*, pp. 477–481, Institute of Management Science and Industrial Engineering, Brasilia, Brazil, October 2019.

[6] S. Mandal, B. Santhi, S. Sridhar, K. Vinolia, and P. Swaminathanm, "Minor fault detection of thermocouple sensor in nuclear power plants using time series analysis," *Annals of Nuclear Energy*, vol. 134, 2019.

[7] J. Choi and S. J. Lee, "Consistency index-based sensor fault detection system for nuclear power plant emergency situa- tions using an LSTM network," *Sensors*, vol. 20, no. 6, 2020.

[8] W. Feng-qin, Y. Jian-guo, S. Xiao-li, and L. Yu, "Application of an improved BP neural network in fault diagnosis of aircraftfuel system," *Computer Measurement and Control*, vol. 14, no. 7, pp. 867–871, 2006.

[9] M. E. Tipping, "Sparse Bayesian learning and the relevance vector machine," *Journal of Machine Learning Research*, vol. 1,no. 3, pp. 211–244, 2001.

[10] J.-C. Jeng, C.-C. Li, and H.-P. Huang, "Fault detection and isolation for dynamic processes using recursive principal component analysis (PCA) based on filtering of signals," *Asia- Pacific Journal of Chemical Engineering*, vol. 2, no. 6, pp. 501–509, 2007.

[11] M. Navi, N. Meskin, and M. Davoodi, "Sensor fault detection andisolation of an industrial gas turbine using partial adaptive KPCA,"*Journal of Process Control*, vol. 64, no. 21, pp. 37–48, 2018.

[12] J. Burriel-Valencia, R. Puche-Panadero, and J. Martinez- Roman, "Automatic fault diagnostic system for inductionmotors under transient regime optimized with expert sys- tems," *Electronics*, vol. 8, no. 1, 2018.

[13] M. Tan, S. Yuan, S. Li, Y. Su, H. Li, and F. H. He, "Ultra-short- term industrial power demand forecasting using LSTM based hybrid ensemble learning," *IEEE Transactions on Power Systems*, vol. 35, no. 4, pp. 2937–2948, 2020.

[14] G.-kai Ma, WuLi-gang, and Y. Wang, "A general subspace ensemble learning framework via totally-corrective boosting and tensor-based and local patch-based extensions for gait recognition," *Pattern Recognition*, vol. 66, 2017.

[15] C.-W. Deng, G.-B. Huang, J. Xu, and J.-X. Tang, "Extreme learning machines: new trends and applications," *ScienceChina (Information Sciences)*, vol. 58, no. 2, pp. 5–20, 2015.

INTEGRATED SOLUTIONS: CIVIL ENGINEERING

CHAPTER-5.1

Installed Effective Use of Water-Resistant Materials in Currently Populated Structure

Anil Kumar[1], Dr. Sanjeev Gill[2]
Assistant Professor, Department of Civil Engineering, JB Institute of Technology, Dehradun, India
H.O.D, Department of Civil Engineering, JB Institute of Technology, Dehradun, India

Abstract- *A human-made structure consists of many parts, including plans, scaling, quality assurance, construction, and upkeep. These elements are used to underpin the wide range of advantages provided by human societies. Before demolishing the building, the degree of construction must be dealt with as it is both a major factor and an important responsibility that must be avoided. Building upkeep and preservation are heavily influenced by water problems, which are stealth killers. In the case of a basement floor made of stone or concrete, water can travel large distances thanks to capillary action. Depending on the density of the surrounding soil and the strength of the concrete, water can seep in through the ground at any point. Each building qualifies because, in addition to dealing with care issues, it also prioritizes the conservation of natural resources. Water plays a major role in the decay or damage that can be done to a structure. Because water is damaging, it is important to select materials that can withstand water and do so without being damaged. Waterproof materials typically fail well before the building they are installed in does. In this post, we'll talk about why and how to utilize waterproofing materials, as well as the different kinds of waterproofing materials available.*

Keywords- Capillary action, human society's stone, concrete, waterproof materials

INTRODUCTION

Waterproofing prevents water from penetrating structures. It forms an impenetrable barrier on floors, ceilings, and walls of structures. Some buildings are designed to be completely impenetrable to water. Waterproofing the structure occurs in stages and layers to ensure that no water can penetrate the structure. It serves to prevent moisture buildup inside of structures. As an added bonus, it keeps the building safe. Deterioration brought on by contact with or exposure to water. The membranes and cracks in the building's exterior and inside work together to keep water out and save the building's contents. "Building Envelope" is a term used to describe the result of combining multiple such types. Hence, the performance of the structure was also evaluated based on the compatibility of the materials, their interaction, and the connection of the enclosed areas of the structures. Furthermore, precipitation and site flow have a significant influence in impeding this performance. Consequently, a waterproofing system can effectively guard against weather, seepages from the earth, and direct passage of water into the building.

Most up-to-date methods of well water protection involve the use of dual-purpose structures. The process can readily carry out multiple tasks thanks to the use of different coatings with different chemical concentrations. Materials used in this procedure have the same energy-saving impact. And that's not all:

Coatings on the exterior and floor walls, which reduce the flow of heat to the building and thus reduce the burden of improving indoor air quality and space atmosphere. Waterproofing systems can also be referred to as "building protection and renovation" or "renewable engineering", due to their versatility and value. Waterproofing is not only a big part of the building process but also preserves the dignity of the landscape. (Grading here means extensively identifying, controlling, and improving the area for proper construction). Therefore, the waterproofing system applies not only to the entire construction envelope, but also to certain parts of the building.

The value of a watertight structure: To some extent, a structure is like a living organism in that it needs care and maintenance to function properly. Problems associated with water and dampness should also be avoided. The following are some typical forms of property damage brought on by water leaks in a structure. Various wall attachments, such as sills, extensions, brickwork joints, etc., can be used to create entry points for water. For a second, there's the problem of groundwater seeping into the basement. Third, an under floor or wall pipe explosion.

And finally, the capillaries are sticking out of the bricks, mortar, and support beams.

How can you tell if a building has a problem with its water proofing, and when it does,

Make sure we have a waterproofing problem if there are any obvious symptoms in the structure.

- The walls are drenched, and the floor is soaked.
- Developing a fungal or bacterial growth The Telltale Symptoms of Decay
- Water-Mixing
- Water seepage through the roof.

Any of these issues can ruin a building's appearance, interior, and even its foundation...One advantage of waterproofing is that it ensures the building remains dry and sturdy. Two, the humidity inside the building is decreased, making it a more pleasant place to live. Third, water vapors and condensation don't harm anything. Strong and long-lasting construction**.**

The Many Waterproofing Materials: Thinking about your house as if you were picking out a waterproof coating is crucial. Thus, it is important to research and comprehend the various waterproofing materials available for the structure in question.

Polyurethane

As such, it serves as a roof's water barrier. The liquid polyurethane membrane's adaptability comes with several advantages, including (but not limited to) the following:

1. sealing capillary cracks.

2. Concrete water absorption should be minimized.

3. Liquid fortifies the concrete's outer layer.

- Application Areas:
- Water tanks
- Pedestrian stairs
- The roof
- Bridges
- Parking area

Cementations waterproof coating: This app provides a very simple program. The mixture contains sand, silica, organic chemicals, and inorganic chemicals. Also, these substances are combined with the function of lime as a sealant.

Application Areas:

- Water treatment plants
- Ports and harbors
- Parking area
- Channels

Bituminous waterproof membrane: Also known as bituminous coating, or asphalt coating, this membrane works effectively against water infiltration. Bituminous is mixed with natural adhesives. Therefore, its viscous quality makes it a very strong waterproofing material for the roof.

There are two ways to use bituminous:

1. Roll roofing material method.
2. Roofing felt method.

EPDM rubber: This waterproofing material is a synthetic rubber material made of propylene and ethylene. Typically, experts associate an EPDM rubber solution with a silicone compound. However, both vary depending on the chemical composition, use, and characteristics.

Also, EPDM rubber is highly adaptable and recyclable.

Application Areas:

- The roof
- Windows
- Wood

Rubberized Asphalt: Another excellent waterproof chemical, Rubberized Asphalt works effectively to protect buildings. The strength, flexibility, and resistance to moisture and the penetration of this vapor make it extremely durable and suitable for structural treatment.

Application Areas:

- The roof
- Plazas
- Parking spaces
- Terrace

Thermoplastic Waterproofing: One of the most effective waterproof materials is thermoplastic. This solid solution provides long-term protection in buildings. Therefore, its anti-inflammatory factor makes it suitable for all heavy treatments.

Application Areas:

- Decks
- Elevator pits
- Fountains

PVC membrane: This feature is often used to prevent water from roofing. Its vapor-permeable material gives it extra strength. The base of the PVC membrane uses polyester mesh or glass fiber.

Application Areas:

- The roof
- Tunnels
- Swimming pools
- Underground structures

Waterproofing paints: Waterproof paint protects the house from environmental damage and improves the health of the building. Therefore, it remains water resistant or completely waterproof. Waterproof paint can be used inside buildings in bathrooms, kitchens, basements, etc. Therefore, it could protect the bathroom and the basement from leaks and excess moisture.

The waterproof paint bathroom wall prevents moisture from entering the walls. Therefore, these paints are preferred over conventional paints as the first one will not stand firm against wet conditions as before. In addition, once moisture has penetrated the walls, mold and mildew will damage the structure and cause health problems.

Types of waterproofing paint

Epoxy paint for waterproofing: Epoxy waterproofing paints use strong chemicals to combat very wet conditions and protect the surface. They make waterproof paint on roofs and water-repellent paints Masonry waterproof paint: Made of a mixture of latex and ceramic paint, waterproof masonry paint is often used for roofing. Also, this paint absorbs chemicals and other liquids easily like water and prevents them from getting inside. It also provides cement with waterproof chemicals.

Acrylic waterproof paint: This type of paint is best suited for roofs and terraces made of rectangular blocks. Also, this paint on the roof and the balcony harmonizes and drains the water on the surface. Additionally, waterproof paint is non-toxic and easy to apply.

PROCESS OF WATERPROOFING: Waterproofing is done horizontally, above the structure, retaining respiratory equipment, to prevent the flow of water and the rise of capillary water in it. The interior displays the water content of the structure and externally forms a protective film around it. Typically, the construction of a waterproofing system is done by creating many barriers to stop the ingress of water, so that it cannot enter the building. This development of multiple layers, materials and methods in them creates a kind of "envelope" of structure around the building. This envelope can be treated as a permanent feature or measure of a green structure by avoiding the ingress of excessive heat from the atmosphere. This can be done by applying various paints, adhesives and other finishes as well as blending that helps create a transition between outside and inside temperatures. This transition between temperatures helps the structure in the following ways:

- Small differences between indoor and outdoor temperatures cause minor weather symptoms and protect the building. This is done in such a way that the effect of compaction or expansion during the various seasons in the material construction of the building is reduced, by matching the room temperature with the external temperature.
- Reduce the burden on the HVAC system, and other procedures that a building occupant often uses to keep the room temperature stable. These reductions can best be attributed to energy savings, drinking water consumption and other utilization of resources. This usually moves the building to a green place.

TYPES OF WATERPROOFING METHODS: There are some common types of waterproofing methods used in the construction industry. Waterproofing in buildings/structures is generally required for:

1. Basement of structure
2. Walls
3. Bathrooms and kitchen
4. Balconies, decks
5. Terrace or roofs
6. Green roofs
7. Water tanks
8. Swimming pools

The following waterproofing methods are commonly used in construction:

1. Cementitious Waterproofing
2. Liquid Waterproofing Membrane
3. Bituminous Membrane
4. Bituminous Coating
5. Polyurethane Liquid Membrane

CEMENTITIOUS WATERPROOFING METHOD: Cementitious waterproofing is an easy way to prevent water from forming. Cement waterproofing materials are readily available in the market. This method is often used in wet indoor areas such as toilets. This method is usually a solid or flexible type that prevents water, but as it is used in indoor areas such as toilets, it is not exposed to sunlight and weather. Therefore, waterproofing with cement does not exceed the contract and the expansion process.

APPLICATIONS OF CEMENTITIOUS WATERPROOFING: Cementitious waterproofing is used in the following type of structures:

1. Water Treatment Plants
2. Sewage Treatment Plants
3. Bridges
4. Dams
5. Railway & Subway Systems
6. Marine Cargo Ports & Docks
7. River Locks/Channels & Concrete Dykes
8. Parking Structures & Lots
9. Tunnels

LIQUID WATERPROOFING MEMBRANE METHOD

Liquid membrane is a thin layer that usually includes the first coat and two coats of top coat used with a spray, roller, or trowel. It offers more flexibility than cementitious types of waterproofing. The liquid heals into a rubber wall. The elongation properties of coating can reach as high as 275%. The durability of a waterproof coat depends on the type of polymer the manufacturer uses to make the liquid waterproofing. A waterproof membrane can be a liquid-coated liquid coated with polymer-modified asphalt. Polyurethane liquid membranes for different levels of trowel, roller, or spray are also available from various manufacturers.

BITUMINOUS COATING WATERPROOFING METHOD: Bituminous coating is a type of coating used for waterproofing and flexible protective coat according to its composition and polymerization stage. Its flexibility and water protection can be influenced by the polymer level and fiber reinforcement. Bituminous coating is also called asphalt coating. The most common applications for bituminous coatings include areas under wet screed. It is an excellent protective agent and waterproofing agent, especially in areas such as concrete foundations. Bituminous coating is made of bitumen-based materials and is not suitable for exposure to the sun. They become very brittle and weak when exposed to prolonged exposure to the sun unless they are prepared with flexible materials such as polyurethane or acrylic-based polymers. The flexibility of the finished products always depends on the solid polymer content added to the bitumen.

BITUMEN MEMBRANE WATERPROOFING APPROACH: Waterproofing of bituminous membranes is a popular method used for low-grade roofing due to their guaranteed performance. Bituminous membrane waterproofing has a flashlight on the lining

and adhesive membranes. Adhesive composites include asphalt, polymers and fillers; in addition, certain resins and oils may be added to improve adhesion properties. The self-adhesive type has a lower shelf life as membrane binding structures shrink over time. The torch on the membrane is exposed and covered with types. Exposed membranes usually contain granular mineral aggregate to withstand the aging and degradation of the weather and other types of membrane, the contractor needs to install a single protective screed to prevent membrane perforations.

POLYURETHANE LIQUID MEMBRANE WATERPROOFING METHOD: The polyurethane liquid membrane waterproofing method is used for the flat roof area and is weatherproof. This method of waterproofing is expensive. The Polyurethane Liquid Membrane can provide high flexibility. Polyurethane is very sensitive to existing moisture, so before installing, one should be very careful checking the moisture content of the concrete slab, otherwise peeling or cracking of the membrane may occur after some time.

CONCLUSION

Water damage can be catastrophic. Water penetration can damage the building's foundations, structure, and valuables. Water penetration can degrade concrete and other construction materials as quickly as wood rots, especially in colder locations where water freezes and causes fractures. Poor waterproofing may be a year-round concern. Permeability allows occupant humidity to be safely vented outside. Waterproofing a building entails preventing water from entering and preventing it from pooling.

REFERENCE

[1] T.Subramani, a.Anbuchezian.(2017)‘water proofing concrete by using fake snow powder’ vol.6, pp.2319-4847.
[2] Abhishek G H, lokesh J K. (2016) ‘evaluation of different kinds of integral water proofing compounds as per IS codes’ vol.5, 2219-8753.
[3] Saurabh borle, gadget (2016) ‘comparative study of conventional and morden water proofing techniques’, Volume: 5 Issue: 1, pp. 32-36.
[4] Richard Pkadlubowski AiA. (2010) ‘water proofing’ Vol. 27.
[5] A.Geetha P.perumal (2011) ‘chemical reaction of waterproofing admixtures on the corrosion behavior of reinforced cement concrete’ (2014), pp. 407-411.
[6] Dhiren J Panchal Nehal H shah ‘water proofing challenges and suggested temedial measures for high rise buildings’ (2015) vol-10.
[7] Li Jiye, construction quality problems and prevention measures [M]. China Building Materials Industry Press.2003

CHAPTER-5.2

A Literature Analysis on The Bending Behavior and Tensile Strength of Hybrid Fibre Reinforced Ferro Cement

Namra Fatima[1], Dr. Sanjeev Gill[2]

[1,3]Assistant Professor, Department of Civil Engineering, JB Institute of Technology, Dehradun, India
[2]H.O.D., Department of Civil Engineering, JB Institute of Technology, Dehradun, India
namra8496@gmail.com

Abstract*-Hybrid fibre reinforced Ferro cement was subjected to bending and tensile strength tests. In this study, we provide hybrid composites that combine the best features of more than one type of reinforcing material. A great deal of research was done on various hybrid composites. Reviewing these several studies reveals conflicting numbers for tensile strength and bending. It is highly desirable to incorporate hybrid fibre into Ferro cement since it increases the material's tensile strength capacity, enhances its ductility, and provides strain hardening qualities. Keeping construction costs in poor countries, where raw materials are at a premium, at a reasonable level. The main reason why the packing density isn't increased by adding finer materials is because of this. In particular, applications involving safety structural parts that are needed for ultra-high performance would benefit greatly from a boost in packing density accompanied by an increase in toughness.*

Keywords- Ferro cement, Hybridization, Bending Properties, Tensile strength.

INTRODUCTION

Reinforced concrete is the most often used construction material on Earth, but the fundamental difference between them is the use of wire meshes and a concrete binder that contains larger aggregate sizes. Constructed from hydraulic cement mortar and wire mesh that is close together, ferrocement has a very thin wall and is often used in construction. Metal or other suitable materials can be used to create the mesh. Because of its versatility, ferrocement has become a popular choice for complex architectural structures such as domes, curved building parts, water tanks, and even boats. Ferrocement can be used to build and repair structures. An entirely new type of material is created, one that is distinct from typical reinforced concrete in terms of its properties (strength, deformation, and potential applications). Thin panels or sections can be made with only a thin mortar layer covering the uppermost layers of reinforcement. Compared to ferrocement materials, conventional reinforced concrete materials are more commonly used as load-bearing elements because of a lack of extensive inquiry into the ferrocement materials and their usage as structural elements. The durability and corrosion issues of ferrocement are critical to its success. For the purposes of this definition, a hybrid fibre is one made up of both micro and macro synthetic fibres. It can be divided into the following combinations: It is based on the fibre constitutive response, in which one of the fibres is stronger and stiffer, providing a stiffer and reasonable first-crack strength and ultimate strength. As a result, the second type of fibre, which is more pliable, improves the post-cracking toughness and strain capacity. Combinations based on different aspect ratios are also possible. In the case of fibre reinforced concrete, short fibre bridges tiny fractures restrict their expansion and also postpone the coalescence. Fracture toughness is improved in composites with long fibres because macro fractures are prevented from propagating. Hybridization is the blending of various fibre kinds. By mixing the fibres,

the qualities of the concrete mix can be improved on a number of levels. This composite material outperforms plain and mono fibre in terms of behavioral efficacy. The addition of discontinuous fibres has been recommended by previous studies to boost tensile strength. By using hybrid fibres, the researchers hope to boost ferrocement's overall structural performance. The requirements of a hybrid fibre ferrocement can only be determined by conducting a thorough material investigation. As a first step, to classify the composite's behaviour, a test series employing a method designed for classifying high performance materials is required. There must be strain hardening qualities in the stress-strain connection before this can occur. An analysis of the strain capacity of a material can also be made using the tensile strength test, which evaluates the material's tensile strength as well as its composition.Hybrid fibre reinforced ferrocement.

MATERIAL DESCRIPTION

According to Naaman (2000), the definition of ferrocement has been expanded to include the stipulation that "the fineness of the mortar matrix and its composition should be suitable with the mesh and armature system it is supposed to encase." There is a possibility that the matrix will have discontinuous fibres. This definition was intended to emphasise the compatibility of the matrix with the reinforcement that is used to build a composite, as well as to present the opportunity to use discontinuous fibres or micro fibres to improve the mechanical performance of ferrocement as hybrid composites, should this become necessary. The form of hybrid reinforcement known as fibrous ferrocement has wire mesh as the primary reinforcement and mono fibre as the secondary reinforcement.

Since the publication of Naaman's study in 2000, there have been ongoing efforts to develop ferrocement as a high-performance material or, as Naaman prefers to refer to it, a strain hardening material (Naaman 2007). Due to the interaction of fibres with wire mesh, ferrocement composites benefit from an increase in their structural qualities when fibre is used (Shannag and Bin Ziyyad 2007). Both mono (meaning only one kind) and hybrid (meaning both types) variants of the fibres can be utilized mechanical behaviors. By enhancing the mortar mixtures with the use of additives and fly ash as a partial replacement for cement, structural standards for ferrocement have been improved. This has led to an increase in the use of ferrocement (Arif et al. 2001). Altering the type of reinforcement used and the proportion of it used has also contributed to the improvement of ferrocement's characteristics.

Improvements In The Classification of High Performance Cementations Composites

Today, several different types of cement-based composites are used in practical building applications, including the fabrication of structural parts. Because of this, it is essential to categorise the materials used in the construction of structures according to their performance. Because of material models and the material parameters that they relate to, structural engineering and materials engineering are now recognised as having a link between them. This reflects the behaviour of a material through its physical requirements, which direct its

structural and mechanical behaviours. These behaviours include: (Stang and Li 2004). Compression strength, tensile strain behaviour, flexural response, toughness, and energy absorption are the features of cement-based composites that are significant for the classification of a material's performance. Other properties include flexural response. Because of the risk of failure caused by crashes in the compression zone, compressive strength is an essential property in the design of concrete (known as brittle failure). However, because FRCCs exhibit behaviour that is either quasi-brittle or strain-hardening, compression strength is not a relevant design criterion for these materials.

When the cement paste has reached a point where it is solidified, brittle failure behaviour can develop. At the first crack, which is no longer able to resist any stress, linear stress–strain behaviour is followed by an abrupt reduction of stress. On the other hand, failure in fibre concrete and a few other fibre-reinforced cementitious materials can be described as quasi-brittle. This results in a linear stress–strain behaviour, which is then followed by a softening behaviour. Strain-hardening materials, on the other hand, are defined by their capacity to withstand stress in a manner that is linearly inconsistent with their elastic behaviour. Almost immediately after achieving the first crack load, an increase in strain will take place due to the increasing levels of loading. This will result in substantial deformation.

When compared to brittle or quasi-brittle materials, the maximum strain value of a strain hardening material is often higher (Li 1997). A transition from quasi-brittle to strain hardening failure is only possible under conditions of'steady-state' cracking, which arises under two conditions: (1) the stress at the crack must equal the first crack peak; and (2) the crack opening displacement must be less than the fibre slip caused by the bridging stress. Cement structural specifications have been made to ensure that a transition from quasi-brittle to strain hardening failure is possible.Cement structural specifications have been made to ensure that a transition

According to EI Debs and Naaman, the addition of polyvinyl alcohol mono discontinuous fibre to ferrocement with only one layer of steel mesh but with various wire spacing results in better overall performance in terms of cracking behaviour, yield, and maximum strength than conventional ferrocement does. In another set of experiments, it was found that increasing the number of steel mesh layers from two to four in conjunction with a volume percentage of steel fibres in ferrocement ranging from 1.5 to 2 percent led to an increase in the strength of the material.

APPLICATION

The advantages of flexibility in the fresh casting stage and high ductility in the hard stage have made ECCs attractive for structural applications (Li 2008), including either on their own or in the form of a composite (hybrid) to support other structural materials. This includes applications where the ECCs are used to support other structural materials (Naaman 2007). It has been demonstrated that the one-of-a-kind characteristics of ECCs as strain hardening cementitious composites (SHCCs) are capable of protecting structural elements constructed

of RC from the damaging effects of an aggressive environment by narrowing the cracks that form in these elements (Maalej and Li 1995). Li et al. conducted research on the use of ECCs in concrete structures with the intention of repairing or retrofitting them (2000). According to the findings of the investigation, the use of ECCs is not limited to structures that are already in existence; rather, they are also suitable for protecting structures that have specific requirements, such as high impact resistance, crack width control, an aggressive environment, and a large damage tolerance. Fischer (2010) had great success utilising stand-alone PVA–ECC panels in modular houses by employing them as floor slabs. The panel slabs that were put through their paces in the testing process had advantageous qualities such as relatively high flexural stiffness, ductility, maximum strength failure, and low cost. The environmental benefits are in addition to the advantages brought about by the mechanical and economic aspects. This slab system is more appealing and sustainable thanks to the utilisation of waste materials as filler in the mixing matrix of the ECC floor slab. These waste materials may include FA or slag. According to Li et al. 2004b, it is possible to create green ECCs for sustainable infrastructure in a variety of applications, such as pipelines, cement boards, electrical shafts, pavements, and as overlay systems in bridge decks (Zhanga and Li 2002).

MATERIAL DESCRIPTION

Because it offers the lowest coststrength ratio of all construction materials, concrete continues to be the most commonly utilised material. The issue with concrete is that it has a low tensile strength and behaves in a brittle manner. This causes failure and collapse fast after the first crack appears in the material. This issue, number 37, inspired researchers to study ways to improve the properties of concrete. Steel fibre-reinforced concrete, also known as SFRC, is a type of hybrid-reinforced cementitious material that was first developed in the early 1960s. The addition of steel fibre led to a considerable improvement in the tensile splitting strength, flexural strength, initial cracking strength, toughness, and impact resistance of the material. In addition to this, there was a decrease in fracture width, deflection, shrinkage, and creep (Tejchman and Kozicki 2010). ACI Committee 544 contains a set of guidelines that can be used for the design and specification of material properties (2002). As was mentioned before, the ASTM Standard (2011a) categorised FRC based on the type of fibre it was made of, including steel, glass, synthetic, and natural fibre.

The behaviour and qualities of mechanical systems

Flexural testing was used to undertake experimental investigations of steel fibre-reinforced beams with changing fibre content (Altun, Haktanir, and Ari 2007). The fibre content ranged from 0 to 60 kg/m3 of the beam's volume. Compression, elastic modulus, and toughness were some of the qualities that were mentioned. The findings showed that the increase in the fibre content did not cause a substantial decrease in the compressive strength, and the results showed that a capacity of good flexural strength could be attained by utilizing 30 kg/m3 (1.25 percent volume fraction). Shear testing was carried out on SFRC beams utilizing a variety of stirrup configurations and fibre contents. Lim and Oh (1999) conducted an experiment, the results of which suggested that further shear reinforcement is not necessary in SFRC.

However, other experiments revealed that a fibre volume percentage of 1.5 percent was sufficient to obtain excellent shear strength capacities (Juárez et al. 2007).

In order to, investigate the tension stiffening and cracking behavior of SFRC specimens with conventional longitudinal reinforcement, standard uniaxial tension tests are often carried out on these samples. There was reported to be an increase in the post-load yielding capacity, in addition to the development of various fracture forming behaviors. This was in comparison to the standard RC (Deluce and Vecchio 2013). Take note that the percentage of fibres present in the mixing matrix has a major impact on the FRC's capacity for withstanding tensile stress (Sujivorakul 2012). During tensile testing, synthetic FRC showed a crack behavior that was comparable to that of natural FRC (Wang, Li and Backer 1990).

DURABILITY OF THE MATERIAL AND ITS APPLICATIONS

The application of a material in building is based, from a structural point of view, on the mechanical performance of the material as well as its durability. According to Li and Stang (2004), cementitious materials have a strong correlation between their structural level durability and their ductility. Corrosion can occur on steel rebars if there is not enough concrete covering them or if the permeability of the cracks that form around them is enhanced. The addition of fibre to concrete increases its resistance to cracking and narrows the cracks that do appear. When compared to conventional RC, there is an observed decrease in the permeability of concrete as well as an increase in the overall impact on the environment (Banthia and Bhargava 2007; Bentur, Diamond, and Berke 1997).

A durability performance evaluation of FRC in a hostile environment employing fractured fibre-reinforced shotcrete revealed difficulties with the material's durability as a result of sulphate and salt solution attack (Kaufmann 2014). According to the results of the test, environmental conditions very comparable to those seen in tunnel construction are present. It was demonstrated that steel fibres in cracks corrode, which leads to a loss of the structure's potential for residual strength. On the other hand, 39 uncracked samples demonstrated a higher level of resistance behaviour during a specified time period. In addition to this, it was found that polymer fibre had a greater level of durability in these kinds of conditions.

There are a number of different application possibilities made possible by the production of FRC using shotcrete or pre-casting procedures. Pipeline trench applications, sewage channel applications, tunnel lining applications, railroad track beam uses for high-speed trains, and precast concrete fence panel applications are some of the places that FRCs are put to use (Banthia et al. 2012). These are the broad applications of fibre reinforced concrete; constructions that are subjected to blast or impact loading are good examples of more particular applications of matrix modified FRC. Bindiganavile, Banthia, and Aarup (2002), for instance, investigated the influence of impact load response on ultra-high-strength compact steel fibre reinforced concrete. The matrix was experimentally investigated under drop-weight impact load, and it contained Portland cement, SF (24 percent by weight of cement), and 6 percent steel fibre volume fraction (quasi-static loading). The material

demonstrated three times the strength and energy absorption of regular FRC thanks to its unique composition. This demonstrates that as a result of the material's great resistance to impact, it is appropriate for use in strategically significant structures such as those associated with high-security or the military.

CONCLUSION

In the numerical modelling, both the microscopic and the structural levels were taken into consideration. On the basis of the findings presented in this part of the investigation, one can draw the following conclusions:

• The FEM model that simulated the RVE (micro structural model) in order to compute the elastic modulus confirmed, to some degree, the results of the experiment that were conducted in order to determine the elastic modulus. The results of the FE simulation revealed that the values for the elastic modulus had moderately increased with time. When compared to the results of the experiment, the variations between the values that were obtained and those that were achieved through experimentation were less than 4%.

• The application of the numerical model to the HFF panel while it was being subjected to flexure produced outstanding results when compared with the experimental data utilising the elastic modules received from the nanoindentation test. This served as a strong indication that the elastic modulus that was empirically found is in good agreement with the FE model.

• The finite element modelling of the HFF–OWC slab exhibited good composite action, and there were no symptoms of the slab fracturing as a result of horizontal shear transfer.

REFERENCES

[1] Abushawashi, N., Vimonsatit, V. and Hopkins, G. 2012. "Shotcrete prefabricated ferrocement panels by using WA mixture materials." Research, Development, and Practice in Structural Engineering and Construction, Perth, Australia.
[2] Juárez, C. Valdez, P. Durán, A and Konstantin Sobolev. 2007. "The Diagonal Tension Behavior of Fiber Reinforced Concrete Beams." Cement and Concrete Composites 29 (5):402–408.
[3] Ravichandran, A., Suguna, K. and Ragunath, P.N 2009. "Strength Modeling of HighStrength Concrete with Hybrid Fibre Reinforcement." American Journal of Applied Sciences 6 (2): 219–223.
[4] Vandamme, M. and Ulm, F.-J 2009. "Nanogranular Origin of Concrete Creep." Proceedings of the National Academy of Sciences 106:10552–10557.
[5] Vimonsatit, V. Wahyuni, Ade S. and Nikraz, N 2012. "Reinforced Concrete Beams with Lightweight Concrete Infill." Scientific Research and Essays 7 (14): 2370-2379.
[6] Wahyuni, Ade S., Vimonsatit, V and Nikraz, N 2012. "Shear Behaviour of Ligthweight Sandwich Reinforced Concrete Slabs." Advances in Structural Engineering.
[7] Wua, Min, Johannesson, B and Geiker, M 2012. "A Review: Self-healing in Cementitious Materials and Engineered Cementitious Composite as a Self-healing Material." Construction and Building Materials 28:571–583.

CHAPTER-5.3

Human Wellbeing Impacts of Air Contamination

Namra Fatima[1], Dr. Sanjeev Gill[2], Shubham Gairola[3]
[1]Assistant Professor, Department of Civil Engineering, Maya Institute of Technology & Management, Dehradun, India
[2]H.O.D., Department of Civil Engineering, JB Institute of Technology, Dehradun, India
[3]Assistant Professor, Department of Civil Engineering, Maya Institute of Technology & Management, Dehradun, India

Abstract-*Dangerous synthetic substances break to the climate by various regular or potentially anthropogenic exercises and may cause antagonistic impacts on human wellbeing and the climate. Expanded burning of non-renewable energy sources somewhat recently is liable for the dynamic change in the atmospheric creation. Air poisons, like carbon monoxide (CO), sulfur dioxide (SO2), nitrogen oxides (NOx), unstable natural mixtures (VOCs), ozone (O3), weighty metals, and respirable particulate matter (PM2.5 and PM10), vary in their synthetic creation, response appropriate ties, discharge, season of deterioration and capacity to diffuse in lengthy or brief distances. Air contamination affects human wellbeing, influencing various frameworks and organs. It goes from minor upper respiratory disturbance to constant respiratory and coronary illness, cellular breakdown in the lungs, intense respiratory contaminations in kids and persistent bronchitis in grown-ups, exasperating previous heart and lung sickness, or asthmatic assaults. Furthermore, short-and long haul openings have likewise been connected with untimely mortality and decreased future. These impacts of air toxins on human wellbeing and their instrument of activity are momentarily examined.*

Keywords: Air pollutant; Human health; Cellular actions; Detoxification

INTRODUCTION

Despite the fact that a variety of natural occurrences (volcanoes, fire, etc.) have the potential to discharge a variety of pollutants into the environment, anthropogenic activities are the main contributor to environmental air pollution. However, a number of air pollutants are discharged by industrial facilities and other activities and may have adverse impacts on both human health and the ecosystem. Hazardous chemicals can accidentally escape into the environment. Any substance that has the potential to harm people, animals, plants, or other materials is by definition an air pollutant. In terms of people, an air pollution may increase the risk of death or serious disease, pose a risk to their health now or in the future, or all of these things. determining whether or not a material is dangerous to human health.

POLLUTANT CATEGORIES

The burning of fossil fuels for the production of energy and transportation is the primary cause of the major change in the composition of the atmosphere. Numerous air pollutants have been identified, each with unique chemical make-ups, reactions, emissions, environmental permanence, ability to travel over long or short distances, and potential effects on human and/or animal health. However, they do have some things in common, and they fall into one of four categories:

1. Pollutants that are gaseous, such as SO2, NOx, CO, ozone, and volatile organic compounds.

2. Long-lasting organic contaminants, such as dioxins.

3. Heavy metals, including lead and mercury.

4. Particulate Matter.

Gaseous pollutants are mostly caused by the combustion of fossil fuels and play a significant role in changes in the composition of the atmosphere (Katsouyanni, 2003). Nitrogen oxides are released as NO, which combines quickly with ozone or other airborne radicals to generate NO2. Mobile and stationary combustion sources are the principal anthropogenic sources of emissions. Additionally, sunlight triggers a sequence of processes involving NO2 and volatile organic molecules that result in the formation of ozone in the lower atmospheric layers. On the other hand, incomplete combustion results in the production of CO. The main source of it is also the road system. While the combustion of sulfur-containing fossil fuels (mostly coal and heavy oils) and the smelting of sulfide-containing ores produce anthropogenic SO2, volcanic eruptions and oceans are its major natural sources. The latter account for just 2% of all emissions. The so-called volatile organic compounds (VOCs) are a significant class of substances that fuel combustion, particularly combustion processes for energy production and vehicle transport, which are the largest source of emission. This group of chemicals comprises chemical species with an organic character, including benzene. Even while most gaseous pollutants are breathed and primarily have an adverse effect on the respiratory system, they can also cause cancer and haematological issues (CO, benzene).

Continually present organic pollutants are a dangerous class of chemicals. They linger in the environment for a long time, and when they ascend the food chain, their effects are amplified (bio-magnification). Pesticides, as well as dioxins, furans, and PCBs, are among them. Dibenzo-dioxins (PCDDs) and polychlorinated dibenzo-furans (PCDFs) are generally referred to as "dioxins," although polychlorinated biphenyls (PCBs) are referred to as "dioxin like compounds" and can operate similarly in terms of dioxin-type toxicity (Schecter et al., 2006). Dioxins are produced anytime materials containing chlorine (such plastics) are burned, as well as during incomplete combustion. Dioxins are airborne pollutants that deposit on soil and water but do not affect groundwater supplies because they are not water soluble. Most dioxins in plants come from air and residue or pesticides and enter the natural order of things where they bio-amass because of their capacity to be steadily bound to lipids.

Weighty metals incorporate essential metal components, for example, lead, mercury, cadmium silver nickel, vanadium, chromium and manganese. They are regular parts of the world's outside layer; they can't be debased or annihilated, and can be shipped via air, and enter water and human food supply. Furthermore, they enter the climate through a wide assortment of sources, including burning, squander water releases and manufacturing offices. To a little degree they enter human bodies where, as minor components, they are fundamental to keep up with the typical metabolic responses. Be that as it may, at higher (in spite of the fact that relatively low) focuses they can become harmful (Jarup, 2003). Most weighty metals are hazardous in light of the fact that they tend to bio-gather in the human body.

Bioaccumulation implies an expansion in the centralization of a synthetic in a biological life form over the long run, contrasted with the compound's focus in the climate. Compounds amass in organic entities any time they are taken in and put away quicker than they are separated (used) or discharged.

Particulate matter (PM) is the conventional term utilized for a sort of air contaminations, comprising of complicated and differing combinations of particles suspended in the breathing air, which shift in size and organization, and are delivered by a wide assortment of regular and anthropogenic exercises (Poschl, 2005). Significant wellsprings of particulate contamination are industrial facilities, power plants, re-combine incinerators, engine vehicles, development action, flames, and normal windblown residue. The size of the particles differs (PM2.5 and PM10 for streamlined width more modest than2.5 mm and 10 mm separately) and various classes have been characterized: Ultrafine particles, less than 0.1 mm in streamlined distance across, Fine particles, less than 1 mm, and Coarse particles, bigger than 1 mm. The size of the particles decides the site in the respiratory lot that they will store: PM10 particles store chiefly in the upper respiratory parcel while fine and ultra-fine particles can arrive at lung alveoli. Up to this point, no single part has been distinguished that could make sense of a large portion of the PM impacts. Among the boundaries that assume a significant part for evoking wellbeing impacts are the size and surface of particles, their number and their composition. The organization of PM changes, as they can ingest and move a huge number of poisons. In any case, their major com-ponents are metals, natural mixtures, material of biologic beginning, particles, responsive gases, and the molecule carbon center. There is solid proof to help that ultra-fine and fine particles are more dangerous than bigger ones (coarse particles), regarding mortality and cardiovascular and respiratory impacts. Moreover, the metal substance, the presence of PAHs and other natural parts like endotoxins, fundamentally add to PM poisonousness.

ROUTES OF OPENNESS

People enter in touch with various air poisons primarily by means of inward breath and ingestion, while dermal contact rep-loathes a minor course of openness. Air contamination contributes, by and large, to the tainting of food and water, which makes ingestion in a few cases the significant course of poison consumption (Thron, 1996). Through the gastrointestinal and respiratory parcel, retention of contaminations might happen, while various harmful substances can be tracked down in the overall flow and store to various tissues. Disposal happens partially by discharge (Rankle and Fowler, 2000).

HEALTH IMPACTS

Irregular air contamination occasions, similar to the notable London haze in 1952 and various short and long haul epidemiological examinations researched the impacts of air quality changes on hu-man wellbeing. A steady finding is that air contaminations add to expanded mortality and emergency clinic confirmations (Brunekreefand Holgate, 2002). The different sythesis of air pollut-insects, the portion and season of openness and the way that people are

normally presented to poison combinations than to single sub-positions, can prompt assorted influences on human wellbeing. Human wellbeing impacts can go from sickness and trouble in breath-ing or skin aggravation, to disease. They likewise incorporate birth deserts, serious formative defers in kids, and decreased action of the resistant framework, prompting various illnesses. More-finished, there exist a few vulnerability factors, for example, age, nu-tritional status and inclining conditions. Wellbeing impacts can be recognized to intense, persistent excluding malignant growth and harmful. Epidemiological and creature model information demonstrate that basically impacted frameworks are the cardiovascular and the respiratory framework. In any case, the capability of a few different organs can be likewise impacted (Cohen et al., 2005; Huang and Ghio, 2006; Kunzli and Tager, 2005; Sharma and Agrawal, 2005).

• Effects Of Air Contaminations On Various Organs And Frameworks

1.Respiratory Framework

Various examinations depict that a wide range of air contamination, at high focus, can influence the aviation routes. In any case, sim-ilar impacts are additionally seen with long haul openness to bring down contamination focuses. Side effects like nose and throat ir-ritation, trailed by bronchoconstriction and dyspnoea, espe-cially in asthmatic people, are typically capable after openness to expanded degrees of sulfur dioxide (Balmes et al., 1987), nitrogen oxides (Kagawa, 1985), and certain weighty metals like arsenic, nickel or vanadium. Also particulate matter that enters the alveolar epithelium (Ghio and Huang, 2004) and ozone start lung irritation (Uysal and Schapira, 2003). In patients with lung sores or lung dis-facilitates, poison started irritation will deteriorate their con-dition. Besides air contaminations, for example, nitrogen oxides increment the helplessness to respiratory diseases (Chauhan et al., 1998). At long last ongoing openness to ozone and certain weighty metals diminishes lung capability (Rastogi et al., 1991; Tager et al., 2005), while the later are additionally liable for asthma, emphysema, and even cellular breakdown in the lungs (Kuo et al., 2006; Nawrot et al., 2006). Emphysema-like sores have additionally been seen in mice presented to nitrogen dioxide (Wegmann et al., 2005).

2.Cardiovascular Framework

Carbon monoxide ties to hemoglobin changing its con-arrangement and decreases its ability to move oxygen (Badman and Jaffe, 1996). This diminished oxygen accessibility can influence the capability of various organs (and particularly high oxygen-consuming organs like the mind and the heart), bringing about debilitated focus, slow reflexes, and disarray. Aside from lung aggravation, fundamental provocative changes are induced by particulate matter, influencing similarly blood coagulation (Riediker et al., 2004). Air contamination that actuates lung disturbance and changes in blood coagulating can block (heart) veins, prompting angina or even to myocardial infraction

(Vermylen et al., 2005). Side effects, for example, tachycardia, in-wrinkled circulatory strain and weakness because of an inhibitory impact on haematopoiesis have been seen as a result

of weighty metal contamination (explicitly mercury, nickel and arsenic) (Huang and Ghio, 2006). At last, epidemiologic examinations have connected dioxin openness to expanded mortality brought about by ische-mic coronary illness, while in mice, it was demonstrated the way that weighty metals can likewise increment fatty oil levels (Dalton et al., 2001).

3. Nervous Framework

The sensory system is essentially impacted by weighty metals (lead, mercury and arsenic) and dioxins. Neurotoxicity prompting neuropathies, with side effects, for example, memory aggravations, rest issues, outrage, weariness, hand quakes, obscured vision, and slurred discourse, have been seen after arsenic, lead and mercury openness (Ewan and Pamphlett, 1996; Ratnaike, 2003). Particularly, lead openness makes injury the dopamine framework, glutamate framework, and N-methyl-D-Aspartate (NMDA) receptor complex, which assume a significant part in memory capabilities (Lasley and Gilbert, 2000; Lasley et al., 2001). Mer-cury is additionally answerable for specific instances of neurological can-cer. Dioxins decline nerve conduction speed and disabled mental advancement of kids (Thomke et al., 1999; Walkowiak et al., 2001).

4. Urinary Framework

Weighty metals can initiate kidney harm, for example, an underlying cylindrical brokenness proved by an expanded discharge of low atomic weight proteins, which advances to diminished glomerular filtration rate (GFR). Furthermore they increment the gamble of stone arrangement or nephrocalcinosis (Damek-Poprawa and Sawicka-Kapusta, 2003; Jarup, 2003; Loghman-Adham, 1997) and renal malignant growth (Boffetta et al., 1993; Vamvakas et al., 1993).

5. Digestive Framework

Dioxins actuate liver cell harm (Kimbrough et al., 1977), as demonstrated by an expansion in levels of specific chemicals in the blood (see following conversation on the fundamental cell components of activity), as well as gastrointestinal and liver malignant growth (Mandal, 2005).

• Exposure During Pregnancy

Somewhat critical to make reference to air contaminations can likewise influence the creating hatchling (Schell et al., 2006). Maternal openness to weighty metals and particularly to lead, expands the dangers of unconstrained fetus removal and decreased fetal development (pre-term conveyance, low birth weight). There are likewise proves proposing that parental lead openness is additionally answerable for intrinsic distortions (Bellinger, 2005), and sores of the creating sensory system, causing significant debilitation in infant's engine and mental capacities (Garza et al., 2006). Additionally, dioxins were viewed as moved from the mother to the hatchling through the placenta. They go about as endocrine disruptors and influence development and improvement of the focal anxiousarrangement of the hatchling (Wang et al., 2004). In this regard, TCDD is considered as a formative poison in all species inspected.

CELLULAR COMPONENTS ENGAGED WITH AIR CONTAMINATIONS ACTIVITIES

Normal cell component by which most air poisons apply their unfavorable impacts is their capacity to act straightforwardly as supportive of oxidants of lipids and proteins or as freerevolutionariesgenerators, advancing oxidative pressure and the enlistment of incendiary reactions (Menzel, 1994; Rahman and MacNee, 2000). Free revolutionaries (responsive oxygen and nitrogen species) are destructive to cell lipids, proteins, and atomic or mitochondrial-DNA, repressing their typical capability (Valko et al., 2006). What's more, they can obstruct flagging pathways inside cells (Valko et al., 2006). In eukaryotic high-impact living beings including people, free extremists are consistently produced during ordinary digestion and in light of exogenous environmental openings (for example light, tobacco smoke, metals and ozone). At the point when free extreme fixation expands, because of a mind-boggling of life form's guard, a condition of oxidative pressure happens. This oxidative state has been ensnared in a wide assortment of degenerative illnesses, for example, atherosclerosis, respiratory failures, stir up, constant fiery sicknesses (rheumatoid joint pain), waterfall, focal sensory system issues (Parkinson's, and Alzheimer's sickness), age related messes lastly disease.

Moreover, the poisonous impacts of weighty metals, aside from actuating oxidative pressure, can be additionally credited to their capacity to substitute different polyvalent cations (calcium, zinc, and magnesium) that capability as charge transporters, mediators in catalyzed responses, or as primary components in the maintenance of protein conformity. For sure, metals aggregate in cell organelles and disrupt their capability. For example it has been seen that lead collection in mitochondria prompts a few changes, for example, hindrance of Ca2þ take-up, decrease of the transmembrane potential, oxidation of pyridine nucleotides, and a quick arrival of gathered Ca2þ (Chavez et al., 1987). Besides, metals tie to proteins(Goering, 1993) and hinder countless proteins, including the mitochondrial ones (Rossi et al., 1993). Nucleic corrosive restricting proteins are additionally involved, while it has been demonstrated the way that metals can likewise tie to DNA, influencing the expression of qualities. For instance nickel enters the core, connects with chromatin and quiets the statement of qualities, for example, cancer silencer qualities, instigating carcinogenesis (Costa et al., 2003). At long last, a few metals disrupt different volt-age-and ligand-gated ionic channels applying neurotoxic effects. For example lead influences the N-methyl-D-aspartic corrosive (NMDA) receptor, subtypes of voltage-and calcium-gated potassium channels, cholinergic receptors and voltage-gated calcium channels (Garza et al., 2006; Toscano and Guilarte, 2005).

Dioxin causes a wide scope of unfavorable impacts (Birnbaum, 1994): they modify digestion by instigating various metabolic chemicals (for example CYPs, glutathione-transferase, tyrosine kinase and so on), homeostasis, through chemical regulation (for example estrogens, androgens glucocorticoids, insulin, thyroid hormones) and their receptors, and development and separation by slowing down development factors (for example EGF, TGFa, TNFa) and

their receptors. At the cell level, dioxins communicate with the aryl hydrocarbon receptor (AhR) (Schwarz et al., 2000) which has an essential helix-circle helix space, going about as a record factor after atomic movement, permitting interaction of dioxins with DNA. The receptor-ligand complex ties to explicit locales on DNA, changing the declaration of various qualities.

All things considered from the information introduced above obviously most toxins assume a significant part in the commencement, advancement and movement of disease cells (Fig. 1).

NATURAL SECURITY

In our everyday life we are uncovered in various types of poisons. Wellbeing influences, as currently portrayed above, rely upon the contamination type, its fixation, length of openness, other existing together poisons and individual vulnerability.

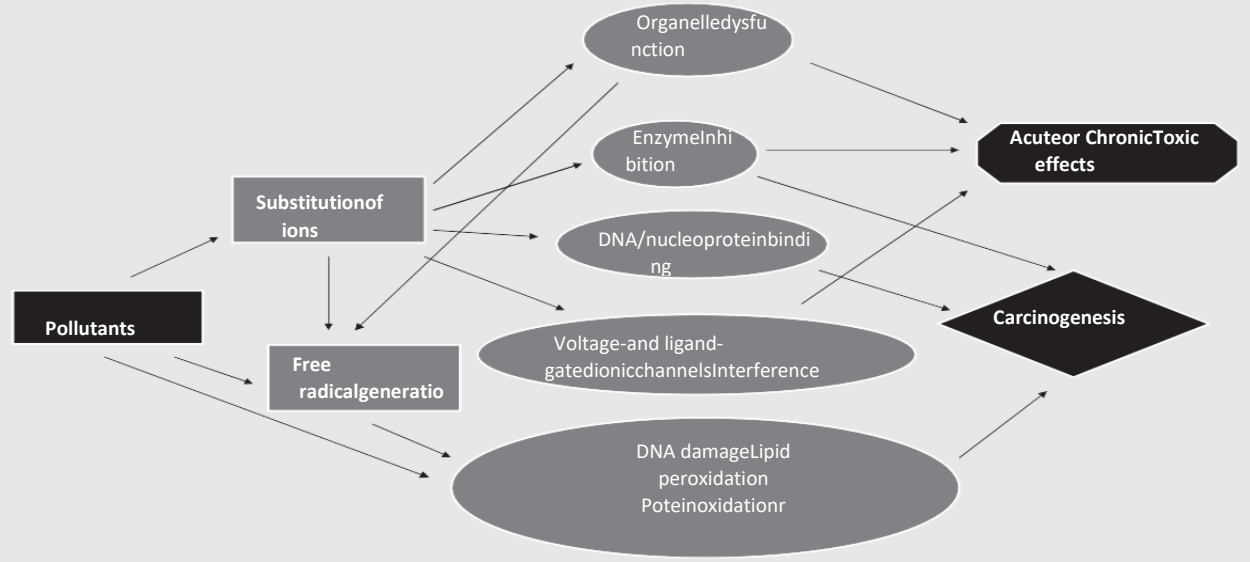


Fig.1.Basic mechanisms of carcinogenesis

Individuals living in urban communities are presented positively, as a con-grouping of expanded industrialization and requests for energy and engine vehicles. Word related openness is additionally a significant component that ought to be thought about. During the last ten years, wellbeing impacts of air contamination are concentrated on additional in created nations, while more and better environ-mental checking information are expected to arrangement limit levels. Furthermore endeavors ought to be heightened by going to the fitting lengths, to decrease the chance of hu-man poison openness.

The human body, to safeguard itself against the potential hurtful put-downs from the climate, is furnished with drug or xenobiotic utilizing proteins (DMEs or XMEs) that assume a focal part in the biotransformation, digestion as well as detoxification of xenobiotics or unfamiliar mixtures, including various types of contaminations. XMEs incorporate different catalysts like cytochrome P450 (P450 or CYP), epoxide hydrolase, glutathione transferase, UDP-glucuronosyltransferase, sulfotransferase, NAD(P)H quinone oxidoreductase 1, and aldo-keto reductase. These chemicals fundamentally partake in the transformation of xenobiotics to

more polar and water-dissolvable metabolites, which are promptly discharged from the body. At long last, it ought to be noticed that, by and large, the synthetically responsive metabolites delivered during digestion, are similarly destructive and hence go through extra digestion to inert products. Thus, the ultimate result of a compound balancing the detoxification catalyst frameworks is the outcome the consequences for the different metabolic pathways.

Various substances of dietary nature are gainful, defensive, and steady of good wellbeing and the body's own normal chelation components. They incorporate supplements with regular chelating properties, which might assist with detoxifying the body, like cell reinforcements, spices, minerals, fundamental amino acids, other detoxifying or defensive specialists, and fiber (Kelly, 2004). Among them dietary cell reinforcements add to the living being's cell reinforcement protection framework, that incorporates a progression of cancer prevention agent enzymatic (for example peroxidase) and non-enzymatic mixtures, (for example, glutathione, or food-inferred like vitamin E, or polyphenols), as well as harm evacuation/fix proteins.

A few regular mixtures, like nutrients C, E, and An and polyphenols, tracked down in most of plant food varieties, between fere with or search ROS focus inside cells and sub-sequently shield the organic entity from the unfriendly impacts of oxidative pressure. For sure, as it has been shown by our gathering that the cell reinforcement movement of plasma in people following an eating regimen wealthy in vegetables, products of the soil oil was expanded in contrast with a typical eating routine (Kampa et al., 2002). This in-wrinkle can be primarily credited to polyphenols which display a great many organic exercises, including hostile to tumorigenic, against mutagenic, calming, and antiviral activities (Bravo, 1998; Hertog and Hollman, 1996) fundamentally because of their cell reinforcement properties and their capacity to apply inhibitory effects by influencing essential cell capabilities. To be sure the beneficial job of polyphenols in forestalling disease can be to some degree ascribed to their capacity to adjust catalysts that actuate or detoxify natural cancer-causing agents.

CONCLUSION

This short survey presents the unfavorable impacts of various (air) poisons in human wellbeing. As displayed, major impairments of various organs can be noticed. The principal conclusion drawn is that, considering expanded openness of people in a variety of contaminations, dietary mediations, wealthy in plant-determined food varieties, may safeguard or diminish their consequences for various organs. This decision is upheld by various epidemiological investigations on the valuable impact of a Mediterranean-type diet on human wellbeing.

REFERENCES

[1] Badman, D.G., Jaffe, E.R., 1996. Blood and air pollution: state of knowledge and research needs. Otolaryngol. Head NeckSurg. 114,205.
[2] Balmes, J.R., Fine, J.M., Sheppard, D., 1987. Symptomatic bronchoconstriction after short-term inhalation of sulfur dioxide. Am. Rev. Respir. Dis.136,1117.
[3] Bellinger, D.C., 2005. Teratogen update: lead and pregnancy. Birth Defects Res.A Clin. Mol. Teratol 73,409.

[4] Birnbaum, L.S., 1994. The mechanism of dioxin toxicity: relationship to risk assessment. Environ. Health Perspect.102(Suppl.9),157.
[5] Boffetta, P., Merler, E., Vainio, H., 1993. Carcinogenicity of mercury and mercury compounds. Scand. J.Work Environ Health19,1.
[6] Bravo, L., 1998. Polyphenols: chemistry, dietary sources, metabolism, and nutritional significance. Nutr. Rev. 56,317.
[7] Brunekreef, B., Holgate, S.T., 2002. Air pollution and health. Lancet 360,1233.
[8] Chauhan, A.J., Krishna, M.T., Frew, A.J., Holgate, S.T., 1998. Exposure to nitrogen dioxide (NO_2) and respiratory disease risk. Rev. Environ. Health 13,73.
[9] Chavez, E., Jay, D., Bravo, C., 1987. The mechanism of lead-induced mitochondrial Ca2þefflux.J.Bioenerg.Biomembr19,285.
[10] Cohen,A.J.,RossAnderson,H.,Ostro,B.,Pandey,K.D.,Krzyzanowski,M.,Kunzli, N., Gutschmidt, K., Pope, A., Romieu, I., Samet, J.M., Smith, K.,2005.The global burden of disease due to outdoor air-pollution. J.Toxicol.Environ.HealthA68,1301.
[11] Costa, M., Yan, Y., Zhao, D., Salnikow, K., 2003. Molecular mechanisms of nickel carcinogenesis: gene-silencing by nickel delivery to the nucleus and gene-activation/inactivation by nickel-induced cell signaling. J.Environ.Monit.5,222.
[12] Dalton, T.P., Kerzee, J.K., Wang, B., Miller, M., Dieter, M.Z., Lorenz, J.N., Shertzer, H.G., Nerbert, D.W., Puga, A., 2001. Dioxin exposure is an environmental risk factor for ischemic heart disease. Cardiovasc. Toxicol. 1, 285.
[13] Damek-Poprawa, M., Sawicka-Kapusta, K., 2003. Damage to the liver, kidney, and test is with reference to burden of heavy metals in yellow necked mice from areas around steel works and zincs melters in Poland.Toxicology186,1.
[14] Ewan, K.B., Pamphlett, R., 1996. Increased inorganic mercury in spinal motor neurons following chelating agents. Neurotoxicology17,343.
[15] Garza, A., Vega, R., Soto, E., 2006. Cellular mechanisms of lead neurotoxicity. Med. Sci. Monit.12, RA57.
[16] Ghio,A.J.,Huang,Y.C.,2004.Exposure to concentrated ambient particles (CAPs): a review. Inhal. Toxicol. 16,53.
[17] Goering, P.L., 1993. Lead protein interactions as a basis for lead toxicity. Neurotoxicology 14,45.
[18] Hertog,M.G.,Hollman,P.C.,1996.Potentialhealtheffectsofthedietaryfla-vonolquercetinEur.J.Clin.Nutr.50,63.
[19] Huang,Y.C.,Ghio,A.J.,2006.Vascularеffectsofambientpollutantparticlesandmetals.Curr.Vasc.Pharmacol.4,199.
[20] Jarup,L.,2003.Hazardsofheavymetalcontamination.Br.Med.Bull.68,167.
[21] Kagawa,J.,1985.Evaluationofbiologicalsignificanceofnitrogenoxidesexposure.TokaiJ.Exp.Clin.Med.10,348.
[22] Kampa,M.,Nistikaki,A.,Tsaousis,V.,Maliaraki,N.,Notas,G.,Castanas,E.,2002.Anewautomatedmethodforthe determinationoftheTotal AntioxidantCapacity(TAC)ofhumanplasma,basedonthecrocinbleach-ingassay.BMCClin.Pathol.2,3.
[23] Katsouyanni, K., 2003. Ambient air pollution and health. Br. Med. Bull. 68,143.
[24] Kelly,F.J.,2004.Dietaryantioxidantsandenvironmentalstress.Proc.Nutr.Soc.63,579.
[25] Kimbrough, R.D., Carter, C.D., Liddle, J.A., Cline, R.E., 1977. Epidemiologyandpathologyofatetrachlorodibenzodioxinpoisoningepisode.Arch.Environ.Health32,77.
[26] Kunzli,N.,Tager,I.B.,2005.Airpollution:fromlungtoheart,SwissMed.Wkly135,697.
[27] Kuo, C.Y., Wong, R.H., Lin, J.Y., Lai, J.C., Lee, H., 2006. Accumulation of chromium and nickel metals in lung tumors from lung cancer patients in Taiwan. J.Toxicol.Environ.HealthA69,1337.
[28] Lasley,S.M.,Gilbert,M.E.,2000.Glutamatergiccomponentsunderlyinglead-induced impairments in hippocampal synaptic plasticity. Neurotoxicology21,1057.
[29] Lasley, S.M., Green, M.C., Gilbert, M.E., 2001. Rat hippocampal NMDA re-ceptor binding as a function of chronic lead exposure level. Neurotoxicol.Teratol.23,185.
[30] Loghman-Adham, M., 1997. Renal effects of environmental and occupationalleadexposure.Environ.HealthPerspect.105,928.
[31] Madden, E.F., Fowler, B.A., 2000. Mechanisms of nephrotoxicity from metalcombinations:areview.DrugChem.Toxicol.23,1.
[32] Mandal, P.K., 2005. Dioxin: a review of its environmental effects and its arylhydrocarbonreceptorbiology.J.Comp.Physiol.175,221[B].
[33] Menzel, D.B., 1994. The toxicity of air pollution in experimental animals andhumans:theroleofoxidativestress.Toxicol.Lett.72,269.
[34] Nawrot, T., Plusquin, M., Hogervorst, J., Roels, H.A., Celis, H., Thijs, L.,Vangronsveld, J., Van Hecke, E., Staessen, J.A., 2006. Environmental ex-posure to cadmium and risk of cancer: a prospective population-basedstudy.LancetOncol.7,119.
[35] Poschl, U., 2005, Atmospheric aerosols: composition, transformation, climateandhealtheffects,Angew.Chem.Int.Ed.Engl.44,7520.

[36] Rahman, I., MacNee, W., 2000. Oxidative stress and regulation of glutathioneinlunginflammation.Eur.Respir.J.16,534.
[37] Rastogi,S.K.,Gupta,B.N.,Husain,T.,Chandra,H.,Mathur,N.,Pangtey,B.S.,Chandra,S.V.,Garg,N.,1991.Across-sectionalstudyofpulmonaryfunc-tion among workers exposed to multimetals in the glass bangle industry,Am.J.Ind.Med.20,391.
[38] Ratnaike,R.N.,2003.Acuteandchronicarsenictoxicity.Postgrad.Med.J.79,391.
[39] Riediker,M.,Cascio,W.E.,Griggs,T.R.,Herbst,M.C.,Bromberg,P.A.,Neas, L., Williams, R.W., Devlin, R.B., 2004. Particulate matter exposure in cars is associated with cardiovascular effects in healthy young men, Am.J.Respir.Crit.CareMed.169,934.
[40] Rossi, E., Taketani, S., Garcia-Webb, P., 1993. Lead and the terminal mito-chondrial enzymes of haembio synthesis. Biomed. Chromatogr.7,1.
[41] Schecter, A., Birnbaum, L., Ryan, J.J., Constable, J.D., 2006. Dioxins: an over-view. Environ.Res.101,419.
[42] Schell, L.M., Gallo, M.V., Denham, M., Ravenscroft, J., 2006. Effects of pollution on human growth and development: an introduction. J. Physiol.Anthropol.25,103.
[43] Schwarz, M., Buchmann, A., Stinchcombe, S., Kalkuhl, A., Bock, K., 2000.Ah receptor ligands and tumor promotion: survival of neoplastic cells.Toxicol.Lett.69,112e113.
[44] Sharma,R.K.,Agrawal,M.,2005.Biologicaleffectsofheavymetals:anover-view.J.Environ.Biol.26,301.
[45] Tager, I.B., Balmes, J., Lurmann, F., Ngo, L., Alcorn, S., Kunzli, N., 2005.Chronic exposure to ambient ozone and lung function in young adults.Epidemiology16,751.
[46] Thomke, F., Jung, D., Besser, R., Roder, R., Konietzko, J., Hopf, H.C., 1999.Increasedriskofsensoryneuropathyinworkerswithchloracneafterexpo-sure to 2,3,7,8-polychlorinated dioxins and furans, Acta Neurol. Scand100,1.
[47] Thron,R.W.,1996.Directandindirectexposuretoairpollution.Otolaryngol.HeadNeckSurg.114,281.
[48] Toscano, C.D., Guilarte, T.R., 2005. Lead neurotoxicity: from exposure tomolecularеffects.BrainRes.BrainRes.Rev.49,529.
[49] Uysal, N., Schapira, R.M., 2003. Effects of ozone on lung function and lungdiseases.Curr.Opin.Pulm.Med.9,144.
[50] Valko,M.,Leibfritz,D.,Moncol,J.,Cronin,M.T.,Mazur,M.,Telser,J.,2006.Freeradicalsandantioxidantsinnormalphysiologicalfunctionsandhumandisease,Int.J.Biochem.CellBiol.39,44.
[51] Vamvakas, S., Bittner, D., Koster, U., 1993. Enhanced expression of the pro-oncogenes-mycandc-fosin normal and malignant renal growth.Toxicol.Lett.67,161.
[52] Vermylen, J., Nemmar, A., Nemery, B., Hoylaerts, M.F., 2005. Ambient air-pollution and acute-myocardial infarction. J. Thromb. Haemost. 3, 1955.
[53] Walkowiak, J., Wiener, J.A., Fastabend, A., Heinzow, B., Kramer, U., Schmidt, E., Steingruber, H.J., Wundram, S., Winneke, G., 2001. Environ-mental exposure to polychlorinated biphenyls and quality of the home environment: effects on psycho development in early childhood. Lancet 358,1602.
[54] Wang,S.L.,Lin,C.Y.,Guo,Y.L.,Lin,L.Y.,Chou,W.L.,Chang,L.W.,2004.
[55] Infant exposure to polychlorinated dibenzo-p-dioxins, dibenzofurans and biphenyls (PCDD/Fs,PCBs) relation between prenatal and postnatal exposure. Chemosphere 54,1459.
[56] Wegmann,M., Fehrenbach, A., Heimann, S., Fehrenbach, H., Renz, H., Garn, H., Herz, U., 2005. NO_2-induced airway inflammation is associated with progressive airflow limitation and development of emphysema-like lesions in $C_{57}B_l$/ 6mice. Exp. Toxicol. Pathol. 56, 341.

CHAPTER-5.4

Daily Monsoon Rainfall Prediction using Artificial Neural Network (ANN) for Parbhani District of Maharashtra, India

Ms. Namrata Sah[1], Dr. Sanjeev Gill[2]
[1]Assistant Professor, Department of Civil Engineering, JB Institute of Technology, Dehradun.
[2]H.O.D, Department of Civil Engineering, JB Institute of Technology, Dehradun.
{Email- Shahnamrata1234@gmail.com}

ABSTRACT – *Rainfall is the most complex and difficult elements of hydrological cycle to understand and to model due to the complexity of atmospheric process. Long term prediction of rainfall is important for country like India where economy is mainly depends on agriculture. In the present study an attempt has been made to develop ANN models for prediction of daily rainfall for monsoon season at Parbhani District of Maharashtra, India. For the study, 30 years data (1985 to 2014) have been used. The 80% data (1985-2008) were used for model calibration and remaining 20% data (2008-2014) were used for validation. In the study, Gama test has been used to find best combination of input variables and after that back-propagation algorithm and tan sigmoid activation function were used to train and test the models. It was founded that the models are capable to predict the rainfall with adequate accuracy.*

Keywords- Gamma test, Back propagation.

INTRODUCTION

The critical dependence of human culture on a reliable source of water and its requirement for security from floods and dry seasons resulted in the branch of science, hydrology, which has principally developed in the journey for solutions to water related issues. During rainy season between June to September, south-west monsoon contributes more than 75% of the annual rainfall of India (Singh, 2006). The view of Indian agriculture is very much dependent on beginning of monsoon and depth of rainfall during rainy season. Therefore, any decrease or increase in annual rainfall will always have severe impact on the agriculture sector of India. Therefore, it is essential to forecast the monsoon behavior which will help the farmers and the government to take full advantage of monsoon season. This knowledge can be vital in reducing the damage of crops during low rainfall periods in monsoon seasons. Rainfall is natural climatic phenomena whose prediction is very challenging and demanding. Accurate study on rainfall is vital for the planning and management of the water resources. Nevertheless, rainfall is one of the most complex and difficult element of the hydrological cycle to understand and to model due to the complexity of the atmospheric processes that generate rainfall and tremendous range of variation over a wide range of scales both in space and time (French et al., 1992).

METHOLOGY

Parbhani district was known as “Prabhavati” in ancient times. It is located towards east of Maharashtra and it is one of the eight districts of Marathwada division. The latitude and longitudes of study area is 18.27° to 20.01º N and 76.13° to 77º E. The elevation of the area is

347m above mean sea level. The location of study area is shown in Figure 1. The climate of study area is classified as the tropical. In general the climate of the area is dry during the southwest monsoon season. The year can be divided into four seasons. The cold season from December to February and the hot season (March to May), the southwest monsoon season from June to September and the post-monsoon season from October to November. The annual average rainfall in the area is 888.5 mm. The daily meteorological data of 30 years (1985-2014) were collected from the meteorological observatory of Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra State, India.

The data required for this study were collected of the period (1st June to 30th September) for thirty years from 1985 to 2014.These data involved daily values of rainfall, temperature, relative humidity and wind velocity and were subjected to pre-analysis and formulation of data base. The 80% data (1985-2008) were used for model calibration and remaining 20% data (2008-2014) were used for validation.

Artificial Neural Network (ANN)

A typical neuron of the ANN consists of input: to Propagates input signal to neuron, Synaptic weights: Interneuron connections that weighs their respective input signals, Bias: Threshold that has an effect of either increasing or decreasing the net input and Output: to provides the output signal of the neuron. The basic structure of a neural network. In neural network, every neuron has a number of inputs and outputs. A neuron calculates an output by applying net and transfer function on inputs.

Development of modal

The artificial neural network (ANN) models were trained using multilayer feed-forward neural network with varying number of neurons in single and double hidden layers using hyperbolic tangent activation function. The analysis of different structures of ANN models trained and tested for maximum epoch's value of 1000 and threshold's value as0.001. The daily monsoon rainfall prediction model for a study area has been developed using the combination of the best input parameters given by Gamma test as discussed under Figure 4 i.e. current day vapor pressure and one day and two lag day rainfall, relative humidity, wind speed and temperature, respectively

Result and Discussion

The best-input combination for application to a model was identified using the Gamma Test (GT). The results of gamma test are shown in Table 3. The best combination of input variables was selected based on the least value of Gamma statistic. Therefore, out of 10 models tested for input combinations, it is found that the model that gives the minimum value of gamma is model 8 and thus, it was selected for input-combination for further application in predictions of rainfall using various models.

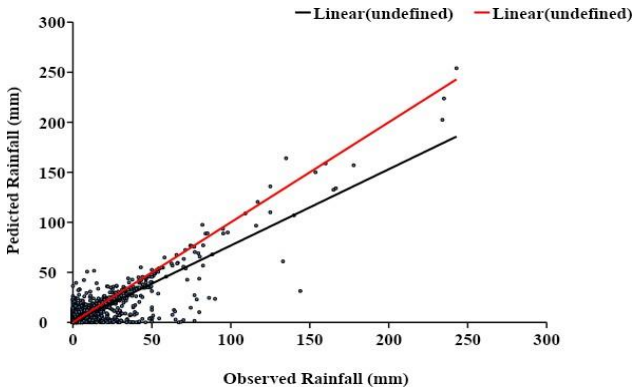


Fig. 1- Comparison of observed and predicted rainfall and their corresponding scatter plot for ANN (9-8-8-1) model during training period.

CONCLUSION

In the model (9-11-1), 9 shows input nodes in the input layer, 11 indicates the 11 number. of neurons in the hidden layer and 1 show the output node in the output layer and in model (9-8-8-1), 9 shows input nodes in the input layer, 8 indicates 8 number of neurons in first hidden layer and second hidden layer, respectively and 1 shows the output node in output layer.In the methodologies available to predict the rainfall, the two factors which need to be estimated with utmost accuracy are the quantum of rainfall and time. The performance of developed models was evaluated using qualitatively. Different structures of ANN model were trained and tested for maximum iterations of 1000 for single and double hidden layers network for forecasting the rainfall. Trial and error method was used for the selection of the network among various structures of the ANN model because there is no specific rule available to determine the best structure of the network.

REFERENCE

[1] Agrawal, P.K., Somvanshi, V.K., Pandey, O.P., Kalanker, N.V., Prakash, M.R. and Chand, R. 2006. Modeling and prediction of rainfall using artificial neural network and ARIMA.
[2] ASCE 2000b. Task committee on application of neural networks in hydrology. Artificial neural networks in hydrology II: Hydrology application. Journal of Hydrologic Engineering, 5(2): 124-137.
[3] Luk, K.C., Ball, J.E. and Sharma, A. 2001. An application of artificial neural networks for rainfall forecasting. Mathematical and Computer Modelling 33: 883-699.Gadgay, B., Kulkarni, S. and Chandrashekhar,
[4] B. 2011. A Neural Network model to predict rainfall in large Indian cities. World Journal of Science and Technology. 1(8): 2231-2587
[5] Partal, T. and Cigizoglu, H.K., 2009. Prediction of daily precipitation using wavelet-neural networks. Journal of Hydrological Sciences, 54(2): 234–246.
[6] Rajurkar, M. P., U.C. Kothyari. and U.C. Chaube. 2004. "Modeling of the daily rainfall-runoff relationship with artificial neural network." Journal of Hydrology 285, no. 1-4 (2004): 96-113.
[7] Singh, C.V. 2006. Pattern characteristics of Indian monsoon rainfall using principal component analysis (PCA). Atmospheric research, 79(3-4): 317-326.

CHAPTER-5.5

An Analysis of the Importance of High-Quality Cement in the Building Industry

Namrata Sah[1], Dr. Sanjeev Gill[2]
[1]Assistant Professor, Department of Civil Engineering, JB Institute of Technology, Dehradun, India
[2]HOD Department of Civil Engineering, JB Institute of Technology, Dehradun, India

ABSTRACT: *It is said that the construction of a nation's infrastructure is that nation's greatest achievement. Because cement and steel are such essential building resources, a nation's consumption of these commodities on a per capita basis can serve as a good measure of its degree of development. Concrete and the substance that acts as its principal precursor, Ordinary Portland Cement (OPC), are so essential to modern society that it is difficult to imagine a future without either of them. In spite of the fact that several kinds of concrete have been developed for specialised applications, the advantages that come with working with any kind of concrete include its low cost, adaptability, durability, and simplicity. The cement industry is thriving all throughout the world, including in India. It is essential for an engineer to select a high-quality cement, despite the fact that there are many new possibilities available. Inadequate cement quality is a common contributor to the failure of construction projects. In this investigation, we will investigate the factors that have a role in determining the type of cement used as well as the classification of cement strength. Controlling the quality of the cement and ensuring that it is consistent in quality are both absolutely necessary. By selecting cement of an adequate quality, it will be possible to provide some level of protection for the project.*

Keywords –high quality cement, OPC, steel, strength.

INTRODUCTION

When it comes to cement production, India ranks second worldwide. Deregulation of the industry in 1982 opened the door to massive investment from both domestic and international companies. Several reforms and adjustments were made in India's cement business so that it would be more in line with government regulations and the industry's bottom line. There was a dramatic increase in cement production from nearly 5 million tonnes in 1952 to over 54 million tonnes in 1993. Poor cement quality and growing production costs as a result of government regulation over a long period of time have led to similarly subpar concrete construction.

Cement demand in India is expected to increase due to government’s push for large infrastructure projects, leading to 45 million tonnes (MT) of cement needed in the next three to four years. India’s cement demand is expected to reach 550-600 Million Tonnes Per Annum (MTPA) by 2025. The housing sector is the biggest demand driver of cement, accounting for about 67 per cent of the total consumption in India. The other major consumers of cement include infrastructure at 13 per cent, commercial construction at 11 per cent and industrial construction at 9 per cent.

The partial relaxation of Government control from March 1982 and a total relaxation of control after March 1989 revived the cement industry and resulted in its phenomenal growth.

This resulted in a competitive market and cement manufactures had to improve their quality of cement, as it was now a battle for survival of the best.

After late 80s cement manufacturers took a huge step modernizing their old plants, which were in various stages of obsolescence. The wet process plants were converted to more economical and dry efficient process or semi-dry process plants. This leads to the production of high-quality cement. Several leading organizations diversified into cement manufacture and thereby created the much-desired consumer-oriented market with the range of brands available at competitive prices. The 33-grade ordinary Portland cement (IS: 269-1989) has virtually disappeared and is displaced by higher strength ordinary Portland cement of 43-grade (IS: 8112-1989) and 53-grade (IS: 12269-1987).

SELECTION OF HIGH-QUALITY CEMENT

Since there are various options available in market the consumer has a good option to select the product required. However, this process depends on the main factor of finance. With the financial constraints, the other factor to be considered is the specifications. It must be understood by the consumer that any good quality product is available at a higher price than a not so good quality product. It is therefore necessary for the consumer to know more about the benefits he gets when he selects a high-quality cement and how best he can put to use such benefits considering both technical as well as the economic aspects.

A high strength cement although preferable to a lower strength cement may not give a consumer the complete benefit until and unless it is giving consistently high strength with minimum variations. The high strength concrete if specified for any structure will also be more desirable from a durability point of view. It is often observed that low strength concrete is more vulnerable to environmental forces than high strength concrete but at the same time, high strength concrete too needs to be extremely carefully batched, mixed, transported, placed, compacted, and cured.

The durability requirements of the structure are as important, if not more, as the strength of the structure. A strong concrete may not result in high performance concrete if the durability requirements are not complied with.

Selection of high-quality cement can only mean a good beginning, but it does not assure the consumer of a final product, which is the strong and durable concrete structure. However, selection of poor-quality cement or cement of inconsistent quality is like taking a wrong step right at the beginning and will certainly lead to the poor-quality concrete structure if not a disaster.

CEMENT STRENGTH CLASSIFICATION

The most common type of cement used in India is ordinary Portland cement (OPC) and has generally grades viz. 33, 43, 45 grade depending upon the 28 days compressive strength.

IS: 10262-1982 gives us the recommended guidelines for concrete mix design, has classified the cement grade wise from A to F, depending upon 28 days strength as follows.

Table 1: Classification of Cement grades A to F as per IS: 10262-1982.

Grade	Range of 28 days strength of cement (kg/cm^2)
A	325-375
B	375-425
C	425-475
D	475-525
E	525-575
F	575-625
*G	625-675

*Has been introduced in view of higher grade cement available in India. However, it may noted that some brands sold as 53-grade cement generally give 28 days strength of around 625 to 675 kg/Sq.cm and they can be classified even as G grade cement. However, most of the 53-grade cement available in the market generally falls in the category F or above and the 43 grade cement available in the market are generally in the category D. It must be ascertained either from the manufacturer or through laboratory tests the actual strength of the cement before it's use in the concrete mix design to get the maximum benefit of the additional strength and superior quality.

CEMENT SAVING DUE TO HIGH STRENGTH

The relation between the free water-cement ratio (W/C) and concrete strength for different cement strengths (grades A to F) is given in fig. 2 page 8 of IS: 10262-1982. This figure is used to determine the W/C of the concrete mix for specified target concrete strength if the cement grade is known.The target concrete strength (fm) is calculated using the following equation fm=fck+ (t*s) where 'fck' is the specified characteristic strength, 't' is the statistical constant generally equal to 1.65 for the specified accepted proportion of low results of 1 in 20 (see table 2) and 's' is the standard deviation, the values of which are selected depending on the degree of quality control expected under different site conditions (see tables 3 and 4).

Table 2: Value of't' (IS: 10262-1982)

Accepted proportion of low results	Time
1 in 5	0.84
1 in 10	1.28
1 in 15	1.5
1 in 20	1.65
1 in 40	1.96
1 in 100	2.33

Degree of quality control Expected (IS: 10262-1982) under different site conditions. Table 4: Recommended values of standard deviation IS: 10262-1982 standard deviation(s) for a different degree of control N/mm. Sq.

Grade of concrete (fm)	Very good	Good	Fair
M10	2	2.3	3.3
M15	2.5	3.5	4.5
M20	3.6	4.6	5.6
M25	4.3	5.3	6.3
M30	5	6	7
M35	5.3	6.3	7.3
M40	5.6	6.6	7.6
M45	6	7	8
M50	6.4	7.4	8.4
M55	6.7	7.7	8.7
M60	6.8	7.8	8.8
M10	2	2.3	3.3

From table 4 it can be seen that better quality control results in a lesser value of's' and 'fm' for same 'fck'. Therefore, cement consumption works out to be lower when the quality control is better. Hence, for concrete manufacture better quality control results in greater economy. Percentage saving as compared to 'A' grade cement.

Recommendations to improve durability using high strength cement: However, the durability requirements as specified in IS 456- under revision must be satisfied depending on the various exposure conditions. From table 5 it is obvious that concrete manufactured using a higher grade of cement even after considering that lower grade cement may be marginally cheaper than the higher-grade cement.

Requirement of durability as per IS: 456-2000. Maximum cement content, maximum water-cement ratio and a minimum grade of concrete for different exposures with normal weight aggregates of 20 mm nominal maximum size.

Note 1- Cement content prescribed in this is irrespective of the grades of cement and it is inclusive of Mineral Admixtures specifies in IS 456-2000. The additions such as fly ash or ground granulated blast furnace slag may be taken into account in the concrete composition with respect to the cement content and water-cement ratio if the suitability is established and as long as the maximum amounts taken into account do not exceed the limit of pozzolona and slag specified in IS 1489 (part 1) and IS 455 respectively.

Note 2- Minimum grade for plain concrete under mild exposure condition is not specified.

The figure below shows that F grade cement can be utilized for 200 kg/cm. Sq. Reinforced concrete in mild environment condition only while C to E grade cement can be used for mild or moderate environmental conditions. However, for high-performance concrete generally, it is very important to go for a higher grade of concrete (above M25 grade). If this concrete is made with high strength cement then it will fetch both technical as well as a financial advantage. shows the extent to which different grades of cement can be used for different environmental conditions and various grades of concrete.Water cement ratio vs Average 28 days' strength of cement in (kg/ cm.sq.)

It is generally observed that even today the structural engineers and architects specify the M15 and M20 grade of concrete in the coastal area. This has already led to serious durability problems and low performance of concrete structures. M15 grade concrete can be achieved with W/C much greater than 0.55 if 43 and 53 grades of cement are used and since 33-grade cement has now virtually disappeared from the market. All M15 grade concrete structures in coastal areas are therefore bound to be a happy hunting ground for concrete rehabilitation agencies as is being observed at present. The durability problem is most likely to multiply several times if, at the specification stage itself, proper precautions are not taken. Even M20 grade concrete may not be the correct solution to the durability problem in the Urbanized/Industrialized coastal areas.

Lower grades of concretes with the generally poor type of quality control prevalent are observed to be of very poor durability, needing of extensive repairs within a few years. As good quality cement are now available it is strongly recommended to go in for higher grades of concrete i.e. above M25 grade. This will improve the performance of the structures; prove more economical in most cases and in the process of achieving higher strengths it will automatically comply with the durability requirements.

Consistency of cement quality: Concrete mix design(CMD) is one of the techniques to determine the most economic proportions of cement, sand, aggregates, water and other additives. However, after choosing the economic proportions of various materials any change in their physical or chemical property will lead to considerable variations in the desired cohesiveness, workability, strength and durability.

The maximum impact is always due to variation in cement properties and therefore it is not only essential that cement should have good strength, proper fineness and correct setting time but it is also essential that the variation of its chemical and physical properties especially the strength and fineness should be minimal. The good quality in minimizing variations is now possible with proper quality control monitoring systems and modern sophisticated instrumentation control systems the cement manufacturers have installed in their modern up to date plants.

Quality control in cement manufacture: While high strength is the indication of the good physical quality of cement, consistency of this high strength and other physical and chemical

properties is an indication of good quality control and superior technology practiced by the cement manufacturing company.

The quality control in the cement manufacturing plant starts from the inspection and testing of the limestone. Only after extensive testing for its CaO content, it is utilized, making sure that CaO content is uniform. The thoroughly crushed limestone powder is then stored in a stacker. It is reclaimed in vertical slices to get homogenous limestone, which is then conveyed, to the vertical ball mill, which ensures uniformly crushed limestone. After this, homogenization of the limestone is done in the blending silo by means of aeration.Thereafter homogenized materials are passed through series of suspension preheaters and are fed into the kiln for the production of clinker.

Hourly samples of clinker are taken and tested to assure uniformly of quality. On line X-ray analyzers' help in ascertaining the variations in compound compositions of the cement so that immediate action can be taken to improve the quality of the product if required.The clinker is then processed through closed circuit grinding. This ensures proper particle size distribution. A device called high-efficiency cyclonic separator, which controls the grinding process right down to the specific micron size required, does this.

After initial grinding in the tube mill, the materials move into the high-efficiency cyclonic separator. The separator separates the ground particles into two streams. The airflow exerts an aerodynamic force and separates the finer particles (between 5 and 30 microns) from the oversize coarser particles (above 30 microns), which are influenced by centrifugal and gravitational forces.The coarse particles are collected into grit collection and brought for recirculation into the grinding process.

The fine particles are removed from the air stream in high cyclones mounted symmetrically around the separator housing. This process assures that cement has the ideal surface area and the ideal proportion of particle size between 5 to 30 microns. This process guarantees the highest number of a particle between 5 to 30 microns to the extent of over 50%. Hourly samples are taken and tested to assure uniformity of quality.

The consistency of particle size is checked using sophisticated particle size analyzers, which immediately indicate the grain size distribution. Adjustments required in cement productions, if any, can be controlled in the plant to obtain the optimum particle size distribution and thereby assure consistent quality.If cement has a large number of particles finer than 5 microns it tends to set quickly producing high early concrete strength without a corresponding increase later on.

This cement is also more susceptible to moisture attack and hydrates fast resulting in unnecessary wastage. On the other hand, if cement possesses a large number of particles above 30 microns it takes longer time than normal to set and will also display low initial strength which increases at a later stage.The cement is then transferred to the packinghouse where it is packed in woven HDPE and 4 ply paper bags and transported to various stockiest and construction sites.

The hourly samples are also collected from the packinghouse to check the quality. Daily tests for various chemical and physical properties are done and various parameters are recorded to study the monthly variations and to improve the product quality from time to time and thereby minimize variations.

Need for consistency of quality: Many do clearly not understand the importance of consistency of cement quality hence a small illustrative example is given below. Assume that three brands of cement say AA, BB and CC are available having identical mean strength for a particular month of manufacture, say 600 kg/cm. Sq. However, the standard deviations for these cement during the same month were different and therefore the characteristic strength of this cement and its grade are worked out as below.

Hence from the above, it can be observed that cement having identical mean 28 days strength for the month can be classified as F, E or D based on the variations (standard deviation). It is therefore of prime importance to control these variations to the barest minimum so that the cement can be classified as a higher grade. It is generally observed that monthly standard deviation if ranging between 15 to 25 kg/cm. Sq. can be considered as a good control for cement manufacture.

There are Additional Cost Savings Associated with using High-Quality Cement that are Worth Noting.

Besides saving of concrete quantity and cement cost per cubic meter of concrete, there are several other advantage and savings due to the use of high strength cement. It is observed that the best advantage of specifying high strength cement is derived if, at the planning and design stage itself, high grades of concretes are specified.

The higher-grade concretes may have a smaller cross-sectional area under identical conditions and thereby the quantity of concrete reduces considerably. The saving in concrete quantity can easily between 1% of 25% depending on the type of structural member, its layout and its function. However, in addition to this saving, higher grades of concrete will be less permeable and more durable than lower grades.

CONCLUSION

- A reduction in the amount of reinforcing steel used.
- A decrease in the necessary amount of formwork has been implemented.
- There will be a reduction in the amount of labour required for finishing touches such as plastering, painting, etc.
- The construction process takes less time and requires fewer personnel, which is one of the many benefits.
- There will be more carpeted space available within the building.

If high cement is defined during the design stage itself and used for the construction of a high-grade concrete structure, then the overall cost of the project will be lower than it would be if a lower-grade cement was specified. The end user will reap the benefits of this in the

form of a structure that is not only more robust but also more long-lasting and cost-effective. Now that we have access to high-grade cement, it is conceivable to simultaneously achieve quality, speed, and economy. Therefore, ensure that your concrete structure is both "quick" and "long-lasting."

REFERENCES

[1] (IS: 12269-1987) ‘Specification for 53 grade Ordinary Portland Cement’ Bureau of Indian Standards, New Delhi.
[2] https://storify.com/jackdawson/how-to-determine-right-quality-of-cement
[3] IS: 456 ‘Plain and reinforced concrete’ Bureau of Indian Standards, New Delhi.
[4] Biaton Pavingttp://www.biatonpaving.co.za/the-advantages/’
[5] Punmia b.c. ”R.C.C.DESIGNS” laxmi publication (p) ltd.
[6] Kumar Sushil “Treasure of r.c.c. design” rajsons publication pvt.ltd.
[7] Sing Gurucharan, Singh Jagdish “ Theory &design r.c.c. structure”, standard publishers distributors.

CHAPTER-5.6

Development of Ann Models Using Monthly Rainfall for Central Telangana Region

Namrata Sah[1], Dr. Sanjeev Gill[2], Anil kumar[3]
[1,3]Assistant Professor,JBIT,Dehradun,India, 248197
[2]HOD, JBIT,Dehradun, India,

ABSTRACT – *In the present study, artificial neural network technique has been employed to predict monthly rainfall forMedak, Khammam and Warangal stations of Central Telangana, India. The eighty-five years (January, 1901 to December, 1985) of rainfall data were used for training of models and twenty-eight years (January, 1986 to December, 2014) of rainfall data were used for testing of models. Gamma test, autocorrelation function and cross correlation function were used for selection of appropriate input variables. The ANN models were trained using multilayer perception with two learning rules i.e. Levenberg-Marquardt and Delta-bar-delta and two transfer functions viz. Sigmoid axon and Tanh axon. Itwas observed that the better results of monthly rainfall prediction of developed models were observed when rainfall of adjoining stations was used as inputs variable as compared to lagged rainfall of the same station. suggest that the M-8 model, K-7 model and W-5 may be used to predict monthly rainfall of Medak, Khammam and Warangal stations respectively for Central Telangana region.*

Keywords- Rainfall, neurons, runoff, networks and monsoon.

INTRODUCTION

Changes in water quantity are occurring mainly as consequences of global and local changes actuated by environmental factors, climate change and human induced changes. Rapid population growth and increasing economic activity have brought new challenges to the management of available water resources. Although irrigation is the main water consumption,it is likely to continue in India at present and in the years to come, with demand from other sectors such as drinking and industry increasing significantly. Therefore, it is necessary to properly assess the capacity of water resources. Without a reliable assessment of resource availability, it is impossible to properly plan, design, build, maintain and manage water resources projects to meet competitive demands such as irrigation, drought and flood management, domestic and industrial water supply, and power generation., fisheries and navigation. Water resources (surface water and groundwater) are restored through a continuouscycle of evaporation, precipitation and runoff. The water cycle is driven by global and climatic forces that introduce variation in precipitation and evaporation, which define runoff patterns and water availability over space and time (modulated by natural and artificial storage). Observations made over the past decades and predictions from climate change examples indicate the severity of spatial and temporal variations of water cycle dynamics (IPCC, 2013) [6]. When data is not sufficient and getting accurate predictions is more important than conceiving the actual physics, empirical models remain a good alternative method, and can provide useful results without a costly calibration time.Soft Computing is an emerging field and its main ingredients are fuzzy logic, neural computing, evolutionary

computation, machine learning and probabilistic reasoning. ANN model is a black box models with particular properties which is greatly suited to dynamic nonlinear system modeling. The artificial neural network (ANN) technique for rainfall prediction is adding a new dimension to the system theoretic modeling approach and it is applying in recent years, as a successful tool to solve various problems. Of the rainfall-runoff process. ANN is also a powerful tool in solving complex nonlinear river flow forecasting problems and in particular when the time required generating a forecast is very short. Mathematically, an ANN can be treated as a universal approximation technique having an ability to learn from examples without the need of explicit physics (ASCE, 2000a, b) [2].

METHOLOGY

Telangana state was isolated from north western part of Andhra Pradesh on 2 June 2014 as the recently formed 29th state of India with Hyderabad as its capital. The Godavari and Krishna are two major rivers basin spread in Telangana state. Based on agro-climatic zone, Telangana state is divided into three zones namely northern Telangana zone, central Telangana zone and southern Telangana zone. The study area is central Telangana zone and consists of Medak, Warangal and Khammam districts of Telangana state. This section deal with location, climate and soil attributes of the study area.

Location: The study was conducted in central Telangana region which includes three districts i.e., Medak. The details of rain gauge site and data length of rain gauge stations are given in Table 1.

Table1 Detail of Rainguage

District	Latitude	Longitude	Altitude, (m)	Data
Medak	18.03°N	78.27° E	442	1901-2014
Warangal	18.00° N	79.58° E	302	1901-2014
Khammam	17.25° N	80.15° E	107	1901-2014

Data Acquisition: The monthly rainfall data for the period from January1901to December 2014 for Central Telangana region namely (Medak, Warangal, Khammam) were obtained from Indian Water Portal site from (1901 to 2002) and from Indian Meteorological Department (IMD) of respective districts (2003 to 2014).

The monthly data of rainfall for 113 years from January 2001 to December 2014 were divided into two phases. The first phase is used for training. The training phase used 85 years of data from January, 1901 to December, 1985, and the second phrase 28 years data from January 1986, to December 2014for validation of developed models.

Development for rainfall prediction models: The prediction of rainfall is enormously complex, vibrant, dynamic and nonlinear process, which is affected by many factors which

are frequently inter-related. The methods used for rainfall forecasting range from completely black-box models to very detailed conceptual models. Historically, hydrologists and researchers have used two types of models:

(a) deterministic/conceptualmodels that consider the dynamics of the principal process,

(b) systems theoretical/black-box models that do not consider the principal dynamics of the process.

Moreover, a black box model is an input–output pattern of which there is no erstwhile information available and these models define the casual link between input-output patterns by alteration. One of the approaches for system theoretical modelling based on artificial neural networks has recently become very popular in the field of hydrological modelling and engineering due to their simplicity and adaptability to mug up and gather information from situation. In the present study, artificial neural network models with different activation functions have been developed for prediction rainfall on monthly basis. As the prediction of monthly rainfall is a complex and dynamic process and it needs a proper time lag for its prediction. Therefore, for development of rainfall prediction, different combinations of lag rainfall (i.e. rainfall of current month, previous one month, previous two month, previous three month and four month) as input and rainfall of current month as output were used in runoff prediction.

CONCLUSION

This chapter deals with selection of best input variables based on autocorrelation function, cross correlation function and Gamma test for development and applications of artificial neural networks model to predict monthly rainfall for Central Telangana districts Medak, Warangal, Khammam using monthly rainfall data of one hundred and thirteen years of period (January 1901 to December 20014). The data was divided into two sets *viz*. training data set (January, 1901 to December, 1985) and testing data set (January 1986, to December 2014) and were used for training and testing of developed models.

Artificial neural networks have been proven to be the most successful tool in dealing with highly complicated problems due to their powerful capability to model non-linear systems without the need to make any assumptions. The task here was more complicated because in the field for meteorological observations all decisions were to taken in the visage of uncertainty. Artificial neural network software was used to train multilayer feed-forward neural network with back propagation algorithm. The transfer functions Tanh Axon and Sigmoid Axon with learning algorithm (Levenberg-Marquardt and Delta Bar Delta) were used in this study for month.

REFERENCES

[1] Ilon, B. E. (1975). Wheels for a Course Stable Selfpropelling Vehicle Movable in any Desired Direction on the Ground or Some Other Base. U.S. Patent. U.S.A.

[2] Everett, H.R. (1995). Sensors for Mobile Robots: Theory and Application. A K Peters, Ltd, MA, USA.

[3] Diegel, O.; Badve, A.; Bright, G.; Potgieter, J. &Tlatle, S. (2002). Improved Mecanum Wheel Design for Omni-directional Robots, Proc. 2002 Australian Conference on Robotics and Automation, Auckland, 27-29 Nov. 2002, pp. 117-121.
[4] Borenstein, J.; Everett, H.R. &Feng, L. (1996). Navigating Mobile Robots: Sensors and Omni directional Mobile Robot – Design and Implementation IoanDoroftei, Victor Grosu and VeaceslavSpinu "Gh. Asachi" Technical University of Iasi Romania Techniques. A K Peters, Ltd, MA, USA.
[5] IoanDoroftei; Victor Grosu and VeaceslavSpinu; "Omnidirectional mobile robot- Design and Implimentation" from "Gh.Asachi" Technical university of lasi, Romania.
[6] Olaf Diegel, AparnaBadave, Glen Bright, Johan Potgieter, Sylvester Tlale, (2002) "Improved Mecanum Wheel Design for Omni-directional Robot", Australasian Conference on Robotics And Automation, Auckland.
[7] Ilon, B. E. (1975). Wheels for a Course Stable Selfpropelling Vehicle Movable in any Desired Direction on the Ground or Some Other Base. U.S. Patent. U.S.A.
[8] Everett, H.R. (1995). Sensors for Mobile Robots: Theory and Application. A K Peters, Ltd, MA, USA.
[9] Diegel, O.; Badve, A.; Bright, G.; Potgieter, J. &Tlatle, S. (2002). Improved Mecanum Wheel Design for Omni-directional Robots, Proc. 2002 Australian Conference on Robotics and Automation, Auckland, 27-29 Nov. 2002, pp. 117-121.
[10] Borenstein, J.; Everett, H.R. &Feng, L. (1996). Navigating Mobile Robots: Sensors and Omni directional Mobile Robot – Design and Implementation IoanDoroftei, Victor Grosu and VeaceslavSpinu "Gh. Asachi" Technical University of Iasi Romania Techniques. A K Peters, Ltd, MA, USA.

CHAPTER-5.7

Preparation and Carbonation Hardening of Low Calcium CO_2 Sequestration Materials from Waste Concrete Powder and Calcium Carbide Slag

Shubham Painuli[1], Dr. Sanjeev Gill[2]
[1]Assistant Professor, Department of Civil Engineering, JB Institute of Technology, Dehradun, India, 248197
[2]H.O.D, Department of Civil Engineering, JB Institute of Technology, Dehradun, India, 248197

ABSTRACT: *A series of new low calcium CO_2 sequestration cementitious materials (LCC) with different Ca/Si ratios were prepared by sintering waste concrete fine powder (WCP) and calcium carbide slag (CCS) at different ratios. Their carbonation reaction activity, carbonation hardening properties, phase assemblages, and microstructure were systematically characterized. The results showed that when the WCP: CCS ratio was 70:30, the compressive strength of LCC reached 38 MPa after carbonation for 24h. With the decrease in the WCP: CCS ratio, the carbonation activity of LCC increased significantly. When the WCP: CCS ratio was 45:55, the compressive strength was increased to 109 MPa. Microstructure tests showed that the minerals of LCC gradually changed from CS and C_2AS to C_3S_2 and C_2S. After carbonation, unreacted clinker particles, crystalline $CaCO_3$, and highly polymerized silica formed a dense microstructure, and the impurities of Mg element in the LCC triggered the formation of aragonite.*

INTRODUCTION

Cement is the second most consumed material in the world, but cement production is accompanied by high energy consumption and high CO_2 emissions . In 2021, 4.3 billion tons of cement were produced globally, which generated about 2.3 billion tons of CO_2 and accounted for about 6.5% of global CO_2 emissions . Excessive CO_2 emissions can lead to an increase in the global greenhouse effect , therefore, it is important to reduce CO_2 emissions from the cement industry.

Much work has been done in the cement industry to reduce CO_2, such as the use of alternative fuels with clean energy in the sintering process , alternative calcareous raw materials , the development of low calcium clinker , the use of low-temperature sintering or non-sintering methods to prepare cementitious materials, and CCUS technology . Among these pathways, carbonation-hardening cementitious materials with low-calcium minerals (C_2S, C_3S_2, CS) as the main minerals, also previously reported as low-calcium CO_2 sequestration cementitious materials (LCC) , have received worldwide attention for their ability to not only greatly reduce CO_2 emissions during cementitious material production, but also to sequester large amounts of CO_2 gas during carbonation curing and to prepare prefabricated building products with excellent properties.

Lu et al. sintered LCC containing C_3S_2, γ-C_2S and a small amount of C_2AS at 1320 °C using chemical reagents. The CO_2 uptakes and compressive strength achieved 21.2% and 46.5 MPa, respectively, after carbonation for 6h. Chang et al. sintered LCC composed of β and γ polycrystalline C_2S at 1450 °C using chemical reagents and the early strength reached 46.3 MPa for carbonation 2h. Qian et al. prepared LCC with C_3S_2 and CS as the main

minerals at 1300 °C using industrial limestone and sandstone. Guan et al. sintered a γ–C_2S–based LCC at 1300 °C. The flexural and compressive strengths reached 10.10 MPa and 61.82 MPa after carbonation for 24 h. The above results show that the LCC can achieve high strength after short-term carbonation. However, the raw materials used in those studies were chemical reagents or industrial raw materials. The CO_2 emissions from the decomposition of $CaCO_3$ in the raw materials were also the cause of high CO_2 emissions in the production of LCC. Thus, industrial solid wastes containing CaO can be used as calcareous sources to prepare LCC.

Waste concrete fine powder (WCP) is a fine powder produced during the crushing of waste concrete. According to statistics, the annual construction waste generated by construction, demolition, and renovation has reached about 3.5 billion tons worldwide, of which waste concrete accounts for about 35% . Many studies have reported the recycling of crushed waste concrete as recycled coarse aggregates . However, crushed waste concrete also contains 30% WCP, whereas the utilization of this WCP is still a problem that needs to be solved.

Shen et al. produced a high-value-added supplementary cementitious material by wet carbonation of WCP, which can improve the strength and durability of concrete. Chen et al. used WCP to prepare low-heat cement with rapid early setting and late high strength. Pyo et al. investigated the effect of thermal-mechanical activation of WCP on the properties of cement mixtures and found that thermally activated WCP could effectively improve its reactivity and achieve comparable compressive strengths to OPC at a maximum substitution rate of 40%. The WCP contains a large amount of Si and Ca and could replace traditional raw materials to prepare LCC, which could further reduce CO_2 emissions in the cement industry .

Calcium carbide slag (CCS) is a solid waste from the hydrolysis of calcium carbide to obtain acetylene gas, with $Ca(OH)_2$ as the main component. Acetylene gas can be further used to prepare polyvinyl chloride(PVC). However, nearly 20 tons of CCS are produced in each ton of PVC production. Due to its large quantity and high alkali, untreated CCS will block sewers and clog riverbeds, endangering fisheries production when deposited at landfills. Therefore, its disposal and utilization are urgent . The CCS has been used as a concrete binder and alkaline activator [39,40]. In addition, CCS has almost no CO_2 emissions during calcination and decomposition, so it can be used as a high-quality calcium resource to replace limestone for sintering cement clinker. However, there are still a few related studies focusing on the reuse of CCS in the production of LCC. In addition, the effect of impurity ions in CCS on the sintering and carbonation hardening properties of LCC is not clear.

Therefore, this study aims to prepare a series of new LCCs with different Ca/Si ratios by sintering WCP and CCS at different ratios. The carbonation reaction activity, carbonation hardening properties, phase assemblages, and microstructure were investigated by pH and conductivity, X-ray Diffraction (XRD), thermogravimetric analysis (TG), Fourier transforms-infrared spectroscopy (FT-IR) and scanning electron microscopy (SEM) to reveal the relationship between clinker mineral composition and hardening properties. The effects of impurity ions in WCP and CCS on the sintering and carbonation hardening properties of LCC

were also discussed. The outcome of this study would provide important guidelines for the preparation of LCC from industrial solid waste.

Materials: The WCP was collected in the process of crushing waste concrete and provided by Henan Jiaozuo Qiangnai Group Co., Ltd, which mainly consisted of powders with particle sizes <0.15 mm. The CCS was the semi-wet slag from Henan Jiyuan Lianchuang Chemical. The WCP and CCS were stored after drying and grinding, and their chemical and mineralogical compositions are shown in and According to the XRD patterns, the main minerals of WCP are SiO_2, $CaCO_3$, and C-A-H.

Burnability: Based on the principle that the clinker has less than 1.5% f-CaO and does not produce a large amount of liquid phase to avoid accidental melting, the suitable sintering temperatures of LC-70, LC-65, LC-60, LC-55, LC-50, LC-45, and LC-40 were measured to be 1150 °C, 1150 °C, 1200 °C, 1200 °C, 1250 °C, 1300 °C and 1300 °C respectively, through sintering tests at different temperatures.

CONCLUSIONS

This study aims to prepare LCC by replacing all-natural raw materials with two solid wastes. The following conclusions can be drawn. A series of new LCCs with different Ca/Si ratios were prepared by sintering of WCP and CCS at different ratios (70:30, 65:35, 60:40, 55:45, 50:50, 45:55, 40:60). Moreover, as the proportion of WCP in the raw materials decreased, the sintering temperature required for clinker sintering increased from 1150 °C to 1300 °C, while the sintered minerals changed from CS–C_3S.

REFERENCES

[1] N. Mohamad *et al.*Environmental impact of cement production and Solutions: a reviewMater. Today: Proc.(2022)
[2] J. Hussain *et al.*The impact of natural resource depletion on energy use and CO2 emission in Belt & Road Initiative countries: a cross-country analysis Energy(2020)
[3] A. Woodward *et al.* Climate change and health: on the latest IPCC report Lancet(2014)
[4] T. Staněk *et al.* Active low-energy belite cement Cement Concr. Res.(2015)
[5] L. Wang *et al.*Energy saving benefit, mechanical performance, volume stabilities, hydration properties and products of low heat cement-based materialsEnergy Build.(2018)
[6] A. Goncharov *et al.*Eco-friendly belite cement from crude calcareous oil shale with low calorific valueCement Concr. Res.(2022)
[7] Z. Ghouleh *et al.* Performance of eco-concrete made from waste-derived eco-cement J. Clean. Prod.(2021)
[8] Z. Ghouleh *et al* .Turning municipal solid waste incineration into a cleaner cement production J. Clean. Prod.(2018)

CHAPTER-5.8

Towards "Climate-Resilient" Infrastructure Projects

Manish Kumar[1], Bhaskar Singhal[2], Dr. Sanjeev Gill[3]
[1]Assistant Professor, Department of Civil Engineering, JB Institute of Technology, Dehradun, India
[2]Assistant Professor, Department of Civil Engineering, JB Institute of Technology, Dehradun, India
[3]H.O.D, Department of Civil Engineering, JB Institute of Technology, Dehradun, India
manish.bhati0911@gmail.com

ABSTRACT: *We build our infrastructure projects (IPs) with a specific project timeline within which we expect them to be effective; however, there are times when they are inadequate and fail. Since this failure can be partly explained by climate change (CC) impacts, we recommend IP "protection against climatic influences." In this paper, we ask the following research question: "What kind of intellectual property do we need to be "climate-proof"?" To answer this during the survey, we conducted a literature review and first identified the main impacts of CC on our IP, which we present in the form of a flowchart. Financially, we describe critically with examples how our "climate-proof" intellectual property should be sustainable, green, smart, innovative, and have a low environmental impact. Third, we discuss the important role of social justice in prioritizing our climate-proof intellectual property and the importance of private funding, especially public funding. The involvement of the private sector and the need for well-informed and properly educated engineers and other scientists that should materialize our intellectual property is "climate-proof."*

Keywords: Climate change; Infrastructure projects; Climate proofing; Climate resilience.

INTRODUCTION

Climate change (CC) refers to large-scale changes in average weather indicators such as temperature. Precipitation, wind patterns, and other meteorological factors are it happens over years, decades, centuries, or more. CC about it Long-term trends, such as changes in temperature, humidity, or the state of dryness. T

hese features may be due to natural changes in weather over time and human activities that add to the climate. Greenhouse gas (GHG) emissions such as burning fossil fuels for energy [1] CC create natural disasters that become natural disasters. When people's lives and livelihoods deteriorate [2]. Tables 1-3 Show the basic characteristics of natural disasters that occur around the world. Finally, according to the epidemiology research centre, of the disasters, it shows the following:

(1) The world faces 1178 natural disasters. Mainly (90%) weather-related,

(2) More than 292 million people have been affected by natural disasters. There were floods (25%), storms (25%), and droughts (17%). And fires (2%),

(3) Economic losses from natural disasters amounted to $163.4 billion, with storms (55%), floods (27%), wildfires (9%), and Dry (4%) accounts for about 95% of the total costs [3].

Table 1: Number of natural disasters worldwide.

NaturalDisaster	2018	2019	2020
Droughts	15	16	11
Floods	135	200	200
TemperatureChanges	29	26	9
SevereStorms/Winds	90	96	140
Wildfires	15	18	10
Landslides	13	25	19
Total climate related	308	362	389
Total	338	442	398

Table2: Number of people affected in millions.

Natural Disaster	2018	2019	2020
Droughts	26	23	19
Floods	34	35	34
Temperature Changes	0	0	0
Severe Storms/Winds	20	38	45
Wildfires	0	10	0
Landslides	0	0	0
Total climate related	80	106	98
Total	85	108	99

Table3: Economic losses in billions of US dollars.

Natural Disaster	2018	2019	2020
Droughts	9.4	0.135	7.5
Floods	19.7	36.82	51.45
Temperature Changes	0	0	0

Severe Storms/ Winds	72.8	57.63	93.22
Wildfires	22.8	3.73	11.17
Landslides	0.93	0.2	0.13
Total climate related	125.6	98.52	163.4
Total	133.7	100.9	172.4

ASCE defines 17 categories of infrastructure.Projects (IP): roads, ports, railways, bridges, planes, walls, and drinking water.water, energy, hazardous waste, waterways, surfaces, and parksand recreation, schools, solid waste, wastewater, transportation, andwastewater [4]. We design our IP with a design life, over time.which we hope will be good. In some cases, However, IP proved inadequate and failed; this lackseems to be increasing in recent years.CC, which increases the natural disasters that occur afterwards.natural disasters. When we do not consider CC in the designIP, the latter of which can not only reduce but also create the problem. Because For example, a dikes keeps water away from a certain area, but also Keep the water in if the wall is high or the area is flooded because of it. It's very local. In recent years, management has discovered that. The importance of connection between IP and CC, September In 2015, each United Nations member country received a The Sustainable Development Goals (SDGs) aims to end and prevent poverty. Planet and ensure that inclusive health is achieved.

Until 2030 [5]. The goal of SDG 9 is "Industry, Innovation, and Infrastructure" and SDG 11, "Sustainable Cities and Communities," is a direct Link between IP and CC On March 3, 2021, ASCE began A four-year report for the US IP [4] that is evaluated Use grade: A (exceptional), B (good), C (moderate), or D (poor).and E (failure), based on US infrastructure acceptance Grade C, which shows a small increase from D+ in 2017 and so on these instructions:

(a) Smart investments are needed as soon as possible.with strong leadership, determination, and transparency the country's infrastructure

(b) There should be more long-term and continuous investment.(The country spends half of what is needed to support IP approximately $2.6 billion to close the 10-year investment gap.

(c) Advances in energy efficiency are desirable and innovative.methods, materials, and technologies to enable IPresilience, or quick recovery from natural or man-made hazards.

On August 10, 2021, the Senate passed it bipartisan.(President Joe Biden's Infrastructure), which includes new legislation$550 billion in transportation costs (roads, bridges, etc.)Railway), electricity (high-speed internet and water), pollution, and other measures to combat CC, including a potential $28 billionnetwork infrastructure, resilience, and trust (to support each other) expanding access to clean energy) and $46 billion, respectively, reduce damage from floods, fires, and droughts. 29 days again July 2021, the European Commission

"Technical guidance on the climate assessment of infrastructure at this time.2021-2027" [6].climate testing is an integrated process.Measures of mitigation (neutrality) and adaptation (resilience) of climate changein the development of intellectual property. The guide corresponds to the following the requirements set forth in the legislation for the various EU funds, In particular, Invest EU, Connecting Europe Facility (CEF), and European Regional Development Fund (FEDER) and Cohesion Fund (FC) Just Transition Fund (JTF):

a) Interdependence with the Paris Agreement and the EU climateObjectives.

b) Follow the principles of "energy efficiency first" and "no"No major harm."

Organizations can use the guide, and European private investors to make informed decisions onIP follows a procedure that includes evaluating the climate-related risks your IP address may face in the coming years based on the data.Which can include national or regional CC projections, the long-awaited update to the UN Climate Science Report is expected inAugust. If significant risks are identified, the developer mustIP redesign to manage and reduce them, for example.It can involve changing the design of physical assets to deal with them.High temperatures or create emergency response systems.Floods [7-9].

In this paper we pose the following research question "what IP Do we need it to be 'weather proof'?" To answer this question, we carried out a bibliographical survey and first of all we identified the main CC impacts of our IP that we present with a flowchart. Second, we critically describe with examples the characteristics of our IP it should have to be 'weather proof'. Third, we discuss the issues of social equity in prioritizing our 'climate proof' IP, the importance of private funding, and the need for well-informed and properly educated engineers and other scientists, who are It is expected to materialize our "weather proof" intellectual property.

Climate Change impacts on Infrastructure Projects: Based on the literature, I created the flowchart in Figure 1. This shows the main impact as CC on IP starts its tracks. From changes in "climate index" and "natural disasters" development. To simplify Figure 1, I've included the main six elements. Schedule 1 natural disasters and six broad categories of intellectual property. They are shown in Table 4. Each IP class has different types. Countermeasures against CC effect to be considered Stages of intellectual property development [10,11]. For example, Figure 1 Represents the rise in the climate index "temperature" Creates the risk of consequent "temperature change". Effects of “damage to roads, railways, bridges, sidewalks, etc.” IP "transport". Specified IP may be affected "Road" that changes the layout by planting roadside trees Reduces exposure to road heat and provides cooling Through green and blue infrastructure such as parks and lakes, As well as street trees and other shade [12]. Typically, Various methods in the literature for each category of IP Adapt to CC effects by changing the design and build of this purpose.

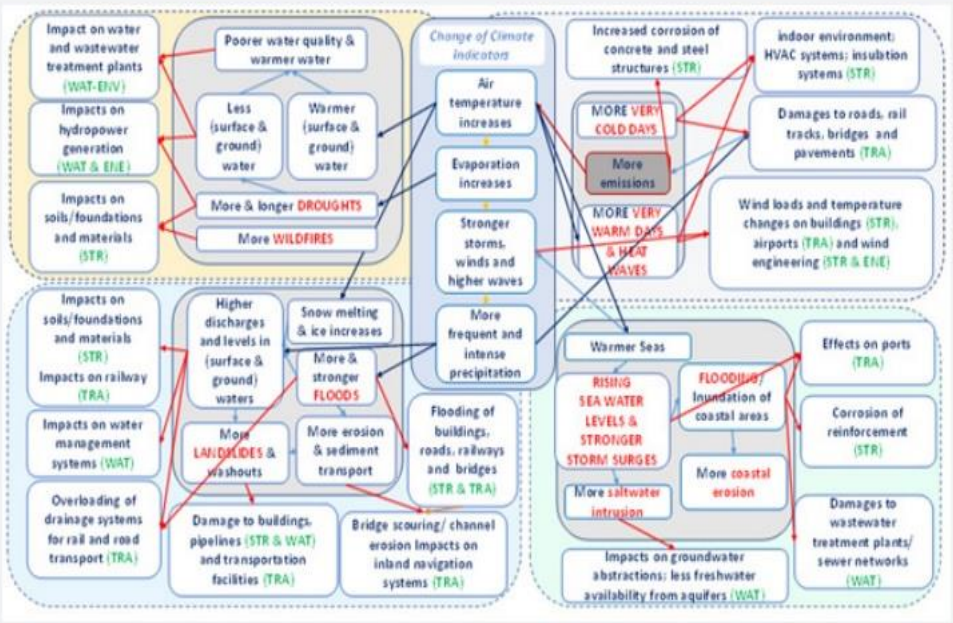


Figure 1: Flow chart of the main impacts of CC on IP.

Table 4: Category of IP and its symbol in Figure 1.

Category of IP	**Symbol**
TRANSPORT: Roads, ports, rail, bridges, transit, aviation, transit etc	TRA
WATER: inland waterways, dams, drinking water, storm water, levees, etc.	WAT
ENERGY	ENE
ENVIRONMENT: Wastewater, hazardous waste, solid waste, etc.	ENV
TELECOMMUNICATIONS	TEL
BUILDINGS / built systems: Hospitals, government buildings, schools, etc.	STR

The needs for 'Climate Proof ' Infrastructure Projects

This section of the book addresses the following basic needs: Developed IP "Climate Proof" based on current international standards literature and experience.

1. A flexible IP that "bends but does not break" is required. Many even existing or new IP do not consider the impact of CC. that's how they do it can create risks. Need to design and build new IP It's flexible, adapts to CC, and can "bend and not break". Of In this way they are able to recover in what is likely to be an increasingly difficult situation horrible situation.

The Six Principles of Resilient IP (P1 to P6) and their objectives (G1 to G6) are the following [13]:

(P1) adaptive transformation - (G1) adaptation and transformation into changing needs.

(P2) Environmentally integrated - (G2) positively functioning in a way that integrates with the natural environment.

(P3) Protected by Design - (G3) Infrastructure Design i.e. Ready to face dangers.

(P4) Socially engaged - (G4) Developing an active commitment, Engage and share with people.

(P5) Shared responsibility - (G5) Sharing information and Experiment to get coordinated benefits.

(P6) Continuous learning - (G6) Develop understanding and Information about infrastructure resilience.

2. We need a green IP. Green infrastructure is a strategy A planned network of natural and semi-natural spaces with another Environmental features that are designed and managed to provide a wide range of ecosystem services, such as water filtration, Air quality and space for recreation and climate protection [14]. This Green (terrestrial) and blue (water) grid can be improved environmental conditions and, consequently, the health and well-being of citizens. Quality of life; In addition, it supports the green economy and job creation opportunities and enhance biodiversity. Green IP addresses are suggested by the European Commission within the framework of the Green Initiative infrastructure strategy [15], which to.

A.Green IP development across the EU to submit Economic, social and environmental benefits and contribution to

sustainable growth,

B. Its implementation at the EU, regional, national and local level. levels through its integration into EU financing flows.

The green infrastructure strategy is integrated into The policies are as follows: to.

A. Climate change policies through ecosystem-based adaptation [16],

B. and innovation policies via nature-based solutions (note) [17],

C. Policies through natural water retention measures [18],

D. Policies through a multi-ecosystem delivery approach Services and rich biodiversity [19].

We can use Green IP to mitigate the negative effects of CC, for Example via:

A. Less tree species and forest practices vulnerable to storms and fires,

B. urban heat islands [20]

C. Apart from land corridors for migration of species [21]

Green IPs is especially important for natural floods Management in watersheds and coastal areas, for example through: to.

A. natural flows through coastal reorganization [22],

B. rivers with their floodplains [23],

C. Wetlands to store flood waters and stop floods,

D. Reservoirs in agricultural areas to store flood water during flood events, for me. sustainable urban drainage using green spaces, permeable surfaces and green surfaces [24,25].

3. We need a smart IP. We are constantly searching improve the effectiveness of our intellectual property; This search along with Evolution of Information and Communication Technology (ICT) Led to the concept of Intelligent IP (Cyber Systems), where Enabling technologies, such as connected sensors and big data Analytics is integrated with the physical infrastructure to achieve it Real-time monitoring, efficient decision-making, and optimization Service provision [26].

Potential benefits of Smart IP include:

a) Maintenance costs b) Damage, and disruption costs (traffic congestion or power blackout)

c) Quality and value of service (on-demand use and flexible tariffs)

d) Protection of human life (less road accidents or better response to disasters, including these related to CC).

These advantages contribute to sustainable urban growth [27]. Smart IP has been applied in various fields, including electricity. distribution systems [28], water and sanitation services [29], Automatic Toll Collection Systems [30], Intelligent Transfer [31] Systems, emergency services and monitoring Infrastructure assets, such as tunnels, bridges, and dams [32]. Most of the above applications are done on a smart system Cities, which are municipalities that use ICTs to increase employability Efficiency and information sharing with the public improves both The quality of government services and the welfare of citizens. the key The components of smart cities are as follows [33]:

A. smart buildings that can reduce water consumption by 30%, 40% energy consumption and 30% maintenance costs.

B. Smart mobility reduces congestion and encourages Cheaper and faster transportation options, usually through Exploiting big data collected from different mobility patterns To help comprehensively improve traffic conditions.

C. Smart energy management systems to automate, monitor, and optimize energy distribution and usage, via sensors, advanced meters, renewable energy sources, digital controls, and analytic tools, including distributed renewable generation, microgrids, smart grid technologies, energy storage, automated demand response, and virtual power plants.

D. Smart water management that typically uses digital technology to help save water, cut costs, and improve water distribution reliability and transparency; typically, it involves

the performance of analyses of the available flow and pressure data in real-time to detect anomalies, such as leaks.

E. Smart waste management that reduces waste, categorizes waste types at the source, and develops waste handling methods via the use of sensors, connectivity, and the Internet of Things

F. Smart health systems, for example via using big data to make predictions or identify population health hotspots, such as epidemics or health impacts during extreme weather events.

4. We need innovative intellectual property. We need innovative solutions and creative engineering achievements in our intellectual property. Innovation Thriving in all phases of exciting infrastructure development New ideas are being generated all over the world; These include The following [34]:

A. Building Information Modeling (BIM). BIM indicates A digital model (software program) of a building that provides information about its components at all stages of development, Beyond Technical 2D Graphics and Computer Aided Design, and Professionals, from architects to engineers and Building managers to collaborate. It is widely believed that BIM has Potential savings of between 15 and 25% on global infrastructure market by 2025 [35]. Moreover, BIM transcends time and Saves money and provides opportunities in construction Not only for "weatherproof" buildings, but also for waste and energy management [36].

B. 3D printing. It is an additive manufacturing process Create a physical (3D) object from a digital design; the operation It works by applying thin layers of material in liquid form or plastic, metal or pulverized cement, and then melt the layers together [37]. As BIM improves IP design, so does 3D printing

It changes the way an IP is actually generated on a site. There Several ways 3D printing combats CC, including reduction Product residue and emissions. IP 3D printing applications Include building components, such as minimally invasive concrete material waste, fasteners with greater design flexibility,

Construction tools, high performance addressable and efficient Communication antennas and valves [38], as well as entire buildings [39] and bridges [40].

C - huge wooden structures. Collective timber is increasingly replacing other building materials such as cement and steel; New products such as CLT (cross-laminated lumber, which is formed by stacking and gluing vertical layers of wood) and glulam (glulam, which consists of stacking and gluing layers of wood directly on top of each other) are enabling wooden taller and stronger buildings Mjøstårnet in Brumunddal, Norway , is the tallest wooden building in the world; It is an 18-storey mixed-use building with a height of 85.4 meters that was completed in March 2019[41]. Replacing traditional building materials with plywood is expected to reduce construction phase emissions by 69%, which corresponds to an average reduction of 216 kg CO2 h/m2 of built-up area, while wood is in half of urban

construction The new ones could achieve emissions targets of 9% by 2030 [42]. It should be noted, however, that attention should also be given to the thermal effects of this substitution or to what degree the climatic benefits may be exaggerated or offset by the thermodynamics of the changing forest landscape, as well as the forest morphology and physical significance. urban buildings. This area of research, as well as forest management strategies and the building design standards that may arise from it, presents a major challenge to a generation of architects, engineers and climatologists focused on restoring and rebalancing our climate. [43].

d- Plastic walkways. It is made entirely from recycled plastic components or mixed with other materials, such as the asphalt used in traditional road construction. Advantages over asphalt include a faster installation time, 3 times longer shelf life, and the introduction of an efficient way to recycle the plastic that ends up in our oceans and landfills [34]. Plastic walkways are hollow to allow room for utility pipes and rainwater drainage; It is also covered with a special coating to prevent the leakage of microplastics, which often end up in our food supply. In 2021, 703 km of roads in India were built using plastic waste [44].

E. Distributed Ledger Technologies (DLT). DTL, like blockchain, has the potential to improve existing processes and systems by acting as a digital enabler across the entire infrastructure value chain [45]. Blockchain is a digital ledger or database that helps verify and track multi-step transactions. While it may be better known for the structure behind the Bitcoin cryptocurrency, it finds uses in everything from product sustainability tracking to real-time pollution monitoring [46]. Blockchain can remove the many layers of contracts and intermediaries that stand between the conception of an IP and its delivery. Blockchain's ability to support smart contracts can be used to pay for important aspects of an infrastructure asset (for example, a subway car or critical parts of a ventilation system) by unlocking direct payments over time to the provider. carrier or installer. . Without a network of separate contracts and intermediary parties [34]. The OECD Case Study Report identifies key areas where blockchain is already impacting the provision of sustainable infrastructure services and presents four original case studies where blockchain can deliver value across the enterprise lifecycle. infrastructure [45].

5. We need an IP with a reduced carbon footprint. Almost 70% of global greenhouse gas emissions come from the construction and operation of IP, primarily including buildings and transportation. The Overseas Development Institute estimates that more than 720 million people could fall back into extreme poverty by 2050 due to CC effects, while the World Health Organization predicts that the number of deaths attributable to the harmful effects of emissions from major infrastructure industries will increase. from 150,000 in the current year to 250,000 by 2030 [47]. Therefore, we need to use more low-carbon IP such as carbon-neutral buildings, railways (instead of carbon-emitting trucks), subways, light rail (instead of cars), and renewable energy projects, such as solar, wind, and hydropower (instead of IP using fossil fuels). The development of digital technology offers the opportunity to reduce the current high carbon footprint; A recent study indicated that the level of digitization with

respect to carbon-related fields is still at an early stage, and academic and practical efforts are required to promote digital development facing the challenging issue of CC [48].

Ensure that our intellectual property is flexible, green, smart, and innovative and Having a low carbon footprint isn't enough. We need to get our priorities in order bye; We need to specify which IP address to check today against Where we can wait and see an approach to allocate our IP address as weather changes. Theoretically, we can combine information From Tables 1-3 showing the most important weather hazards and Figure 1 shows the main implications of these risks for intellectual property To determine which IP deserves priority. In practice, however, this Simplified approach is not possible due to many other factors.

As intellectual property interaction with our society that must be guaranteed Community resilience as well. In the event of a failure of the electrical systems during a Storm, we must ensure that backup plans are in place People still have access to water, heat and medical care. These Plans must start with our most vulnerable communities. thus, We need intellectual property with social justice. Based on a FEMA study on Floods [49], the poor, racial and ethnic minorities, the elderly, Tenants, non-native speakers of English and people with mobility Allied was disproportionately affected by flooding in each district. The important difference between urban areas was the level of citizen empowerment, starting with higher organization

Neighborhood groups and citizens (Chicago) at lower levels of citizens Share (Baltimore). Privileged families are the most likely We have the resources to overcome disasters by moving, pushing repairs and use the savings to make up for lost income. So, Disadvantaged families tend to be hardest hit, even For the same level of physical disorders. They are also often Most affected live in high-risk areas. In addition, disadvantaged communities often have difficulty accessing recovery funds. and advocating for infrastructure reform. Also, recently, strong links have been found between design features of the built environment and historical housing policies that may be directly responsible for the disproportionate exposure of disadvantaged populations to current heat events. Addressing urban heat island effects by paying attention to built and natural infrastructure in cities can help address these inequalities. We need to engage sociologists, psychologists, communicators and educators along with engineers to address equity issues around intellectual property. In addition, we may need to update the methods used to assess risks and vulnerabilities and to identify cost-benefit trade-offs so that small or poor communities are not overlooked [50]. The role of private finance in the development of intellectual property is also very important. We need to improve the attractiveness of IP for private financing and public-private partnerships (PPPs) [51]. For this, we need more transparency in the IP generation process, more certainty regarding the framework conditions for project implementation and less risks for the operational phase. A long-term portfolio of infrastructure projects and better, broader, and more independent cost-benefit analysis are the main levers for achieving this [52].

Last but not least, we need engineers and other scientists who are properly informed and educated. Universities, research institutes, societies, associations and organizations should

include “climate-proof” IP-related topics in their research, teaching and teaching capacity building programmes. Indicative examples are the master’s course “Urban Digital Transformation and Innovation: Governance and Economics of Cities” at Erasmus University Rotterdam [53], the 8-week course “Delivering Sustainable Infrastructure: Theory and Practice for Building” at the University of Cambridge [54], and the training course “Audit Climate for Infrastructure Investments” of the Center for Rural Development (SLE) of the Humboldt University zu Berlin [55]. Similar procedures have been implemented by civil engineering organizations such as ICE and ASCE. ICE has established a climate literacy program and plans to reflect this in its requirements for membership degrees and scholarships [56], while ASCE is focused on how to make infrastructure more resilient against climate change [57].

CONCLUSION

We asked the following research question "What IP address do we need to be 'weatherproof'?" To answer this question, we conducted a literature review and first identified the main CC effects of our IP address which we present with a flowchart. Second, we monetarily describe with examples that our “weatherproof” IP should be resilient, green, smart, innovative, and have a low carbon footprint. Third, we discuss the important role of social justice in prioritizing our “climate-resilient” IP, the importance of private funding, primarily through public-private partnerships, and the need for well-trained engineers and other scientists. who are expected to achieve our IP "weather proof".

REFERENCES

[1] https://www.epa.gov/climatechange-science/frequently-asked-questions-about-climate-change#climate-change
[2] https://public.wmo.int/en/our-mandate/focus-areas/natural-hazards-and-disaster-risk-reduction
[3] (2022)CRED.CentreforResearchontheEpidemiologyofDisasters;https://www.cred.be
[4] https://infrastructurereportcard.org/
[5] https://www.undp.org/iraq/sustainable-development
[6] goals?utm_source=EN&utm_medium=GSR&utm_content=US_UNDP_PaidSearch_Brand_English&utm_campaign=CENTRAL&c_src=CENTRAL&c_src2=GSR&gclid=Cj0KCQjw--2aBhD5ARIsALiRlwB99p9ZdtNXI_7XI_I-oqv3odnQo73pgsDQQXJZ3CI4Dts4FBmniYaApijEALw_wcB
[7] https://ec.europa.eu/clima/sites/default/files/adaptation/what/docs/climate_proofing_guidance_en.pdf
[8] Mitsopoulos G, Bloutsos A, Panagiotatou E, Baltas E, Stamou A (2022) Design Aspects of an Early Warning System for Flash Floods: The Case of the Town of Mandra in Attica, Greece. From Snow to Sea. Proceedings of the 39th IAHR World Congress 19-24.
[9] Stamou A, Mitsopoulos G, Baltas E (2022) Identification of the weak points in the application of a methodology for the design of Flood Early Warning Systems in Climate Change Conditions. The case of the town of Mandra, Attica, Greece,7th IAHR Europe Congress: Innovative Water Management in a Changing Climate. Athens, Greece7-9.
[10] MitsopoulosG,PanagiotatouE,SantV,BaltasE,DiakakisM,LekkasE, Stamou A (2022) Optimizing the Performance of Coupled 1D/2DHydrodynamicModelsforEarlyWarningofFlashFloods.Water14(15).
[11] Olsen,Rolf&Ayyub,Bilal&Walker,Dan&Barros,Ana&Medinaetal. (2015). Adapting Infrastructure and Civil Engineering Practice to aChangingClimate.
[12] StamouAI(2019)AdaptingCivilEngineeringDesigntoClimateChange, HELASCO Conference The Consulting Industry facing NewMarkets.RequirementsandInstruments,Athens,Greecepp:26-27.
[13] ZakiSA,TohHJ,YakubF,MohdSaudiAS,Ardila-ReyJA,etal.(2020) Effects of Roadside Trees and Road Orientation on ThermalEnvironmentinaTropicalCity.Sustainability12:1053.
[14] https://www.undrr.org/publication/principles-resilient-infrastructure

[15] https://ec.europa.eu/environment/nature/ecosystems/pdf/Green%20Infrastructure/GI_climate_adaptation.pdf
[16] https://ec.europa.eu/environment/nature/ecosystems/strategy/index_en.htm
[17] Fabio Rubio Scarano (2017) Ecosystem-based adaptation to climate change: concept, scalability and a role for conservation science. Perspectives in Ecology and Conservation15(2): 65-73.
[18] Panagiotatou E, Stamou A (2022) Mathematical Modelling of Nature-Based Solutions for flood risk reduction under Climate Change conditions. 7thIAHR Europe Congress: Innovative Water Management in a Changing Climate. Athens, Greece pp:7-9.
[19] Zelenakova, Martina, Diaconu, Daniel, Haarstad, Ketil (2017) Urban Water Retention Measures. Procedia Engineering.190:419-426.
[20] Iris Maria Hertog, Sara Brogaard, Torsten Krause (2022) Barriers to expanding continuous cover forestry in Sweden for delivering multiple ecosystem services, Ecosystem Services.53: 101392.
[21] WalterLF,LeyreEI,AliceN,MarisK,EdwardAM(2018)Copingwith the impacts of urban heat islands. A literature-based study onunderstanding urban heat vulnerability and the need for resilience incitiesinaglobalclimatechangecontext.JournalofCleanerProduction
[22] Hilty,Jodi&Worboys,Graeme&Keeley,Annika&Woodley,Stephen&Lausche, et al. (2020) Guidelines for conserving connectivity throughecologicalnetworks andcorridors.
[23] GuerryAD,SilverJ,BeagleJ,WyattK,ArkemaK,etal.(2022)Protection and restoration of coastal habitats yield multiple benefits for urbanresidentsassealevels rise.npjUrbanSustain2:13.
[24] Serra-Llobet Anna, Jähnig Sonja C, Geist Juergen, Kondolf Mathias G, Damm Christian, et al. (2022) Restoring Rivers and Flood plains for Habitat and Flood Risk Reduction: Experiences in Multi-Benefit Flood plain Management From California and Germany. Frontiers in Environmental Science.
[25] https://www.epa.gov/heatislands/using-green-roofs-reduce-heat-islands
[26] GrabowskiZJ,McPhearsonT,MatslerAM,GroffmanP,PickettStewardTA, (2022). What is green infrastructure? A study of definitions in UScity planning. Frontiers in Ecology and the Environment, Front EcolEnviron20(3): 1540-9295.
[27] WeissA(2009)SmartinfrastructurematchessupplyanddemandNetworker.13(3): 18-25.
[28] MorimotoR(2010)Estimatingthebenefitsofeffectivelyandproactivelymaintaininginfrastructurewiththeinnovativesmartinfrastructuresensorsystem.Socio-economicPlanningSciences44(4): 247 257.
[29] JayachandranM,PrasadaRaoK,RanjithKumarG,KalaivaniC,KalaiarasyC,etal.(2022)Operationalconcernsand solutionsinsmartelectricitydistribution systems. UtilitiesPolicy 74: 101329.
[30] Martin Oberascher, Wolfgang Rauch, Robert Sitzenfrei, (2022)Towards a smart water city: A comprehensive review of applications, data requirements, and communication technologies for integratedmanagement.SustainableCitiesandSociety76: 103442.
[31] Nag, Dipanjan & Roy, Anibrata & Goswami, Arkopal (2020) Estimating Environmental Benefits of Electronic Toll Collection (ETC).10.1007/978-981-32-9042-6_35.
[32] Mohammed Sarrab, Supriya Pulparambil, Medhat Awadalla (2020)Development of an IoT based real-time traffic monitoring system forcitygovernance. GlobalTransitions2:230-245.
[33] Hareesh R, Senthil Kumar RK, Kalluri R, Bindhumadhava BS (2022) Critical Infrastructure Asset Discovery and Monitoring for Cyber Security. In: Pillai RK, Ghatikar G, Sonavane VL, Singh BP (eds) ISUW2020. Lecture Notes in Electrical Engineering, Springer, Singapore847: 289-300.
[34] https://roboticsbiz.com/key-components-of-smart-city-infrastructure-an-overview
[35] https://www.weforum.org/agenda/2019/09/6-revolutionary-techniques-about-to-transform-our-infrastructure
[36] www.eubim.eu
[37] https://blog.wavin.com/en-gb/can-bim-help-the-construction-industry-to-tackle-climate-change
[38] https://www.investopedia.com/terms/1/3d-printing.asp
[39] https://www.fabbaloo.com/news/3d-printing-and-infrastructure-investments-in-developing-countries
[40] https://www.procore.com/jobsite/6-of-the-worlds-most-impressive-3d-printed-buildings
[41] AustinHimes,GwenBusby(2020)Woodbuildingsasaclimatesolution.Developments in the Built Environment 4: 100030.
[42] Churkina G, Organschi A (2022) Willa Transition to Timber Construction Coolthe Climate? Sustainability 14 (7):4271.
[43] https://guinnessworldrecords.com/world-records/79569-tallest-wooden-building
[44] https://timesofindia.indiatimes.com/auto/news/india-constructed-703-km-of-highways-using-plastic-waste/articleshow/84883086.cms
[45] https://www.oecd.org/finance/Blockchain-technologies-as-a-digital-enabler-for-sustainable-infrastructure-key-findings.pdf
[46] https://www.unep.org/news-and-stories/story/battle-against-climate-crisis-dont-overlook-blockchain
[47] https://blogs.worldbank.org/ppps/low-carbon-infrastructure-essential-solution-climate-change
[48] YanJ,QiuchenLu,JunqingTang,LongChen,JingkeHong,etal.(2022) Digital Tools for Revealing and Reducing Carbon Footprint inInfrastructure.Building,andCityScopes.Buildings12(8):1097.

[49] (2019)FramingtheChallengeofUrbanFloodingintheUnitedStates. National Academies of Sciences, Engineering, and Medicine.Washington,DC, USA.
[50] https://www.rand.org/blog/2021/06/promoting-social-equity-in-
[51] Ali M M, Javad M S (2022) Chapter 9- Public–private-partnerships (PPP)enabled smart city funding and financing. Smart Cities Policies andFinancing,Elsevier pp:117-131.
[52] https://blogs.iadb.org/sostenibilidad/en/three-ways-to-improve-the-quality-ofinfrastructure-investments
[53] https://www.findamasters.com/masters-degrees/erasmus-university-rotterdam/
[54] Anastasios Stamou, Department of Water Resources and Environmental Engineering, Laboratory of Applied Hydraulics,NationalTechnical University of Athens,Greece
[55] https://www.unccd.int/cbm/climate-proofing-infrastructure-investments-sle-training
[56] https://www.ice.org.uk/news-insight/media-centre/press-releases-list/climate-change-is-overlooked-in-infrastructure-projects-civil-engineers-warn
[57] https://www.asce.org/publications-and-news/civil-engineering-source/civil-engineering-magazine/issues/magazine-issue/article/2022/01/how-to-make-infrastructure-more-resilient-against-climate-change
[58] https://advanceonline.cam.ac.uk/courses/delivering-sustainable-infrastructure-theory-and-practice-for-construction

CHAPTER-5.9

Hybrid Composite Reinforced Ferro cement Bending Performance and Tensile Strength Literature Review

Ms. Ruchita Saxena[1], Dr. Sanjeev Gill[2]
[1]Assistant Professor, Department of Civil Engineering, JBIT, Dehradun (U.K)
[2]HOD Department of Civil Engineering, JBIT, Dehradun (U.K)
ruchita.saxena96@gmail.com

ABSTRACT*-Reinforced with hybrid fibres Both bending and tensile tests were performed on the ferro cement. The purpose of this research is to develop hybrid composites, which are composites that combine the beneficial qualities of more than one type of reinforcing material. A significant amount of investigation was put into a number of different hybrid composites. When all of these investigations are taken together and compared, the results for bending and tensile strength are inconsistent. Incorporating hybrid fibre into Ferro cement is extremely desirable because doing so boosts the material's tensile strength capability, improves its ductility, and provides strain hardening properties. Maintaining a cost of building that is fair in developing nations where raw resources are in short supply and demand is high. This is the primary reason why adding materials of a smaller particle size does not result in an increase in the packing density. In particular, applications requiring safety structural sections that require extremely high performance would be extremely well served by an increase in packing density accompanied by a rise in toughness. This would be the case because of the synergistic effect of the two factors.*

Keywords- cement, Hybridization, Bending Properties, Tensile strength.

INTRODUCTION

Reinforced concrete is the most often used construction material on Earth, but the fundamental difference between them is the use of wire meshes and a concrete binder that contains larger aggregate sizes. Constructed from hydraulic cement mortar and wire mesh that is close together, ferrocement has a very thin wall and is often used in construction. Metal or other suitable materials can be used to create the mesh. Because of its versatility, ferrocement has become a popular choice for complex architectural structures such as domes, curved building parts, water tanks, and even boats. Ferrocement can be used to build and repair structures. An entirely new type of material is created, one that is distinct from typical reinforced concrete in terms of its properties (strength, deformation, and potential applications). Thin panels or sections can be made with only a thin mortar layer covering the uppermost layers of reinforcement. Compared to ferrocement materials, conventional reinforced concrete materials are more commonly used as load-bearing elements because of a lack of extensive inquiry into the ferrocement materials and their usage as structural elements. The durability and corrosion issues of ferrocement are critical to its success. For the purposes of this definition, a hybrid fibre is one made up of both micro and macro synthetic fibres.It can be divided into the following combinations.It is based on the fibre constitutive response, in which one of the fibres is stronger and stiffer, providing a stiffer and reasonable first-crack strength and also ultimate strength. As a result, the second type of fibre, which is

more pliable, improves the post-cracking toughness and strain capacity. Combinations based on different aspect ratios are also possible. In the case of fiber-reinforced concrete, short fibre bridges tiny fractures restrict their expansion and also postpone the coalescence. Fracture toughness is improved in composites with long fibres because macro fractures are prevented from propagating.Hybridization is the blending of various fibre kinds. By mixing the fibres, the qualities of the concrete mix can be improved on a number of levels. This composite material outperforms plain and mono fibre in terms of behavioural efficacy. The addition of discontinuous fibres has been recommended by previous studies to boost tensile strength. By using hybrid fibres, the researchers hope to boost ferrocement's overall structural performance. The requirements of a hybrid fibre ferrocement can only be determined by conducting a thorough material investigation. As a first step, to classify the composite's behaviour, a test series employing a method designed for classifying high performance materials is required. There must be strain hardening qualities in the stress-strain connection before this can occur. An analysis of the strain capacity of a material can also be made using the tensile strength test, which evaluates the material's tensile strength as well as its composition Hybrid fibre reinforced ferrocement.

According to Naaman (2000), the definition of ferrocement has been expanded to include the stipulation that "the fineness of the mortar matrix and its composition should be suitable with the mesh and armature system it is supposed to encase." There is a possibility that the matrix will have discontinuous fibres. This definition was intended to emphasise the compatibility of the matrix with the reinforcement that is used to build a composite, as well as to present the opportunity to use discontinuous fibres or micro fibres to improve the mechanical performance of ferrocement as hybrid composites, should this become necessary. The form of hybrid reinforcement known as fibrous ferrocement has wire mesh as the primary reinforcement and mono fibre as the secondary reinforcement.

Since the publication of Naaman's study in 2000, there have been ongoing efforts to develop ferrocement as a high performance material or, as Naaman prefers to refer to it, a strain hardening material (Naaman 2007). Due to the interaction of fibres with wire mesh, ferrocement composites benefit from an increase in their structural qualities when fibre is used (Shannag and Bin Ziyyad 2007). Both mono (meaning only one kind) and hybrid (meaning both types) variants of the fibres can be utilised Mechanical behaviour.

By enhancing the mortar mixtures with the use of additives and fly ash as a partial replacement for cement, structural standards for ferrocement have been improved. This has led to an increase in the use of ferrocement (Arif et al. 2001). Altering the type of reinforcement used and the proportion of it used has also contributed to the improvement of ferrocement's characteristics.

Improvements In The Classification Of High Performance Cementations Composites: Today, several different types of cement-based composites are used in practical building applications, including the fabrication of structural parts. Because of this, it is essential to categorise the materials used in the construction of structures according to their performance.

Because of material models and the material parameters that they relate to, structural engineering and materials engineering are now recognised as having a link between them. This reflects the behaviour of a material through its physical requirements, which direct its structural and mechanical behaviours. These behaviours include: (Stang and Li 2004). Compression strength, tensile strain behaviour, flexural response, toughness, and energy absorption are the features of cement-based composites that are significant for the classification of a material's performance. Other properties include flexural response. Because of the risk of failure caused by crashes in the compression zone, compressive strength is an essential property in the design of concrete (known as brittle failure). However, because FRCCs exhibit behaviour that is either quasi-brittle or strain-hardening, compression strength is not a relevant design criterion for these materials.

Figure 2.13 illustrates the various categories of errors that can occur. When the cement paste has reached a point where it is solidified, brittle failure behaviour can develop. At the first crack, which is no longer able to resist any stress, linear stress–strain behaviour is followed by an abrupt reduction of stress (curve A). On the other hand, failure in fibre concrete and a few other fibre-reinforced cementitious materials can be described as quasi-brittle. This results in a linear stress–strain behaviour, which is then followed by a softening behaviour, as demonstrated by curve B. Strain-hardening materials, on the other hand, are defined by their capacity to withstand stress in a manner that is linearly inconsistent with their elastic behaviour. Almost immediately after achieving the first crack load, an increase in strain will take place due to the increasing levels of loading. This will result in substantial deformation (curve C).

When compared to brittle or quasi-brittle materials, the maximum strain value of a strain hardening material is often higher (Li 1997). A transition from quasi-brittle to strain hardening failure is only possible under conditions of'steady-state' cracking, which arises under two conditions: (1) the stress at the crack must equal the first crack peak; and (2) the crack opening displacement must be less than the fibre slip caused by the bridging stress. Cement structural specifications have been made to ensure that a transition from quasi-brittle to strain hardening failure is possible. roCement structural specifications have been made to ensure that a transition

According to EI Debs and Naaman, the addition of polyvinyl alcohol mono discontinuous fibre to ferrocement with only one layer of steel mesh but with various wire spacing results in better overall performance in terms of cracking behaviour, yield, and maximum strength than conventional ferrocement does. In another set of experiments, it was found that increasing the number of steel mesh layers from two to four in conjunction with a volume percentage of steel fibres in ferrocement ranging from 1.5 to 2 percent led to an increase in the strength of the material.

APPLICATION

The advantages of flexibility in the fresh casting stage and high ductility in the hard stage have made ECCs attractive for structural applications (Li 2008), including either on their own or in the form of a composite (hybrid) to support other structural materials. This includes applications where the ECCs are used to support other structural materials (Naaman 2007). It has been demonstrated that the one-of-a-kind characteristics of ECCs as strain hardening cementitious composites (SHCCs) are capable of protecting structural elements constructed of RC from the damaging effects of an aggressive environment by narrowing the cracks that form in these elements (Maalej and Li 1995). Li et al. conducted research on the use of ECCs in concrete structures with the intention of repairing or retrofitting them (2000). According to the findings of the investigation, the use of ECCs is not limited to structures that are already in existence; rather, they are also suitable for protecting structures that have specific requirements, such as high impact resistance, crack width control, an aggressive environment, and a large damage tolerance.

Fischer (2010) had great success utilising stand-alone PVA–ECC panels in modular houses by employing them as floor slabs. The panel slabs that were put through their paces in the testing process had advantageous qualities such as relatively high flexural stiffness, ductility, maximum strength failure, and low cost.

The environmental benefits are in addition to the advantages brought about by the mechanical and economic aspects. This slab system is more appealing and sustainable thanks to the utilisation of waste materials as filler in the mixing matrix of the ECC floor slab. These waste materials may include FA or slag.

According to Li et al. 2004b, it is possible to create green ECCs for sustainable infrastructure in a variety of applications, such as pipelines, cement boards, electrical shafts, pavements, and as overlay systems in bridge decks (Zhanga and Li 2002).

MATERIAL DESCRIPTION

Because it offers the lowest coststrength ratio of all construction materials, concrete continues to be the most commonly utilised material. The issue with concrete is that it has a low tensile strength and behaves in a brittle manner. This causes failure and collapse fast after the first crack appears in the material. This issue, number 37, inspired researchers to study ways to improve the properties of concrete. Steel fiber-reinforced concrete, also known as SFRC, is a type of hybrid-reinforced cementitious material that was first developed in the early 1960s. The addition of steel fibre led to a considerable improvement in the tensile splitting strength, flexural strength, initial cracking strength, toughness, and impact resistance of the material. In addition to this, there was a decrease in fracture width, deflection, shrinkage, and creep (Tejchman and Kozicki 2010). ACI Committee 544 contains a set of guidelines that can be used for the design and specification of material properties (2002). As was mentioned before, the ASTM Standard (2011a) categorised FRC based on the type of fibre it was made of, including steel, glass, synthetic, and natural fibre.

The Behaviour And Qualities Of Mechanical Systems: Flexural testing was used to undertake experimental investigations of steel fiber-reinforced beams with changing fibre content (Altun, Haktanir, and Ari 2007). The fibre content ranged from 0 to 60 kg/m3 of the beam's volume. Compression, elastic modulus, and toughness were some of the qualities that were mentioned. The findings showed that the increase in the fibre content did not cause a substantial decrease in the compressive strength, and the results showed that a capacity of good flexural strength could be attained by utilising 30 kg/m3 (1.25 percent volume fraction)

Shear testing were carried out on SFRC beams utilising a variety of stirrup configurations and fibre contents. Lim and Oh (1999) conducted an experiment, the results of which suggested that further shear reinforcement is not necessary in SFRC. However, other experiments revealed that a fibre volume percentage of 1.5 percent was sufficient to obtain excellent shear strength capacities (Juárez et al. 2007).

In order to investigate the tension stiffening and cracking behaviour of SFRC specimens with conventional longitudinal reinforcement, standard uniaxial tension tests are often carried out on these samples. There was reported to be an increase in the post-load yielding capacity, in addition to the development of various fracture forming behaviours. This was in comparison to the standard RC (Deluce and Vecchio 2013). Take note that the percentage of fibres present in the mixing matrix has a major impact on the FRC's capacity for withstanding tensile stress (Sujivorakul 2012). During tensile testing, synthetic FRC showed a crack behaviour that was comparable to that of natural FRC (Wang, Li and Backer 1990).

Durability Of The Material And Its Applications: The application of a material in building is based, from a structural point of view, on the mechanical performance of the material as well as its durability. According to Li and Stang (2004), cementitious materials have a strong correlation between their structural level durability and their ductility. Corrosion can occur on steel rebars if there is not enough concrete covering them or if the permeability of the cracks that form around them is enhanced. The addition of fibre to concrete increases its resistance to cracking and narrows the cracks that do appear. When compared to conventional RC, there is an observed decrease in the permeability of concrete as well as an increase in the overall impact on the environment (Banthia and Bhargava 2007; Bentur, Diamond, and Berke 1997).

A durability performance evaluation of FRC in a hostile environment employing fractured fiber-reinforced shotcrete revealed difficulties with the material's durability as a result of sulphate and salt solution attack (Kaufmann 2014). According to the results of the test, environmental conditions very comparable to those seen in tunnel construction are present. It was demonstrated that steel fibres in cracks corrode, which leads to a loss of the structure's potential for residual strength. On the other hand, 39 uncracked samples demonstrated a higher level of resistance behaviour during a specified time period. In addition to this, it was found that polymer fibre had a greater level of durability in these kinds of conditions.

There are a number of different application possibilities made possible by the production of FRC using shotcrete or pre-casting procedures. Pipeline trench applications, sewage channel

applications, tunnel lining applications, railroad track beam uses for high-speed trains, and precast concrete fence panel applications are some of the places that FRCs are put to use (Banthia et al. 2012). These are the broad applications of fibre reinforced concrete; constructions that are subjected to blast or impact loading are good examples of more particular applications of matrix-modified FRC. Bindiganavile, Banthia, and Aarup (2002), for instance, investigated the influence of impact load response on ultra-high-strength compact steel fibre reinforced concrete. The matrix was experimentally investigated under drop-weight impact load, and it contained Portland cement, SF (24 percent by weight of cement), and 6 percent steel fibre volume fraction (quasi-static loading). The material demonstrated three times the strength and energy absorption of regular FRC thanks to its unique composition. This demonstrates that as a result of the material's great resistance to impact, it is appropriate for use in strategically significant structures such as those associated with high-security or the military.

CONCLUSIONS

Numerical modelling considered microscopic and structural levels. This phase of the inquiry yields the following conclusions:

• The FEM model that simulated the RVE (micro structural model) to compute the elastic modulus partially matched the experimental results. FE simulations showed that elastic modulus values have substantially increased over time. The values obtained were within 4% of the experimental results.

• The numerical model used to the HFF panel during flexure yielded excellent results compared to experimental data using elastic modules from the nanoindentation test. • The finite element modelling of the HFF–OWC slab showed good composite action and no horizontal shear transfer-induced slab fracturing.

REFERENCES

[1] Abushawashi, N., Vimonsatit, V. and Hopkins, G. 2012. "Shotcrete prefabricated ferrocement panels by using WA mixture materials." Research, Development, and Practice in Structural Engineering and Construction, Perth, Australia

[2] Juárez, C. Valdez, P. Durán, A and Konstantin Sobolev. 2007. "The Diagonal Tension Behavior of Fiber Reinforced Concrete Beams." Cement and Concrete Composites 29 (5):402–408.

[3] Ravichandran, A., Suguna, K. and Ragunath, P.N 2009. "Strength Modeling of HighStrength Concrete with Hybrid Fibre Reinforcement." American Journal of Applied Sciences 6 (2): 219–223.

[4] Vandamme, M. and Ulm, F.-J 2009. "Nanogranular Origin of Concrete Creep." Proceedings of the National Academy of Sciences 106:10552–10557.

[5] Vimonsatit, V. Wahyuni, Ade S. and Nikraz, N 2012. "Reinforced Concrete Beams with Lightweight Concrete Infill." Scientific Research and Essays 7 (14): 2370-2379.

[6] Wahyuni, Ade S., Vimonsatit, V and Nikraz, N 2012. "Shear Behaviour of Ligthweight Sandwich Reinforced Concrete Slabs." Advances in Structural Engineering

[7] Wua, Min, Johannesson, B and Geiker, M 2012. "A Review: Self-healing in Cementitious Materials and Engineered Cementitious Composite as a Self-healing Material." Construction and Building Materials 28:571–583.

CHAPTER-5.10

Experimental Research Regarding the Efficacy of Recycled Aggregate Mortar Was Conducted

Mr. Dimple Sharma[1], Dr. Sanjeev Gill[2]
[1]Assistant Professor, Department of Civil Engineering, Beehive college of Engineering and Technology, Dehradun, India, 248001
[2]H.O.D, Department of Civil Engineering, JB Institute of Technology, Dehradun, India, 248197
dimplesharma413@gmail.com

ABSTRACT- *The use of recycled fine aggregates in the production of mortar is an effective measure that can be taken to increase social and ecological values in today's society in light of the pressing problems associated with the over-exploitation of natural sand and the disposal of construction and demolition wastes. There are a number of methods for recycling fine aggregates. When formulating the recycled aggregate mortar, fluidity was advised as the most significant component to consider in order to reduce the additive effects of the W/C ratio, the quality of the recycled fine aggregates, and their content. The experimental results of this investigation show that the fluidity of recycled aggregate mortar significantly affects its mechanical and permeability qualities. The outcomes of using this mortar are compared to those of using regular mortar. The trials reveal that a higher percentage of water is required for recycled aggregate mortar to obtain the same fluidity as controlled mortar. This is due to the fact that recycled aggregate is known to have lower quality characteristics than regulated mortar, such as a higher initial water absorption and a greater volume of voids within the mortar. The properties of the recycled aggregate mortar's setting were affected by its fluidity, the quality of the recycled fine aggregates, and the content. Also, the setting periods of the recycled mortar were much quicker than those of the controlled mortar. However, the strength characteristics (compressive, tensile, and flexural), pulse velocity value, permeable void content, water absorption by immersion, and sorptivity of recycled aggregate mortar corresponding to fluidities of 110 2.5 mm and 160 2.5 mm were all lower than those attached to fluidities of 135 2.5 mm. Hence, recycled aggregate mortar with a moderate fluidity of 135 2.5 mm is feasible and has enhanced mechanical and permeability properties.*

Keywords- Recycled Aggregate Mortar, permeable void content, demolition wastes

INTRODUCTION

Construction and demolition debris is produced during the building and breaking down of anything, including roads, bridges, flyovers, subways, and any other public works infrastructure. Likewise prevalent is debris from cyclones, floods, earthquakes, explosions, and war. Concrete, plastic, plaster, wood, metal, etc. are common examples of inert and non-biodegradable materials. According to the March 2007 issue of the Hindu published online, India produces almost 23.75 million tonnes of demolition garbage annually. In terms of weight, 40% of the demolition mess is made up of concrete, 30% of ceramics, 5% of plastic, 10% of wood, 5% of metal, and 10% of other miscellaneous materials. During the industrial revolution, demolition debris is simply discarded without being put to any useful purpose. The soil's fertility would be greatly diminished under such conditions. Rapid industrial growth has resulted in a serious shortage of natural aggregates (NA) for the creation of new concrete, and a massive volume of demolished concrete has been formed from crumbling and

obsolete structures, both of which must be disposed of. Instead of using natural aggregates, concrete "garbage" might be used. production by using it as an aggregate. This "recycled" concrete can also be a reliable replacement for natural aggregates. The need to conserve natural resources (such as stone, river sand, soil, etc.) and energy, as well as the fact that C&D waste is transported over long distances only to be dumped, as well as the fact that it takes up valuable landfill space and degrades the processing of biodegradable and recyclable materials, call for increased attention to C&D waste. Construction and demolition waste generation and disposal have risen to the status of strategic issues in the industry, mostly as a result of the rapid urbanisation and industrialization taking place throughout the world. Disposing of these garbage causes serious environmental and ecological issues. Naturally, it is necessary to intervene and look for alternatives to trash disposal. Aggregate consumption is predicted to rise from 37,400 metric tonnes per year in 2010 to 51.7 billion metric tonnes in 2019 at an average annual rate of 37,400 metric tonnes. Natural aggregates (NA) are being used at such a rapid rate that it is putting enormous strain on the ecosystems around us. Because of this, the use of recycled aggregates (RA) in the construction industry is critical to reducing waste disposal and the use of natural resources, which have both social and environmental impacts. Concrete/mortar/other building components can be made using RCA and RFA recycled aggregates, two size fractions of recycled aggregates. This is an easy and sensible way to enhance sustainability in concrete/mortar/other building components.

Read the scholarly papers: Ping Hua Zhu has carried out a research on carbonation resistance of recycled aggregate concrete (RAC) subjected to different loading level was carried out. Three series of concrete mixtures were produced with loading level of 0.5, 0.8, and 1.2 of ultimately tensive strength of concrete. Carbonation resistance of recycled aggregate concrete reduces according with increasing water-binder ratio. There is an excellent linear relationship formed for recycled aggregate concrete between carbonation depth and square-root of carbonation.

Jodilson Amorim Carneiro has reported that the utilisation of recycled aggregate from construction and demolition waste (CDW) as replacement of fine and coarse natural aggregate has increased in recent years in order to reduce the high consumption of natural resources by the civil construction sector. In this work, an experimental investigation was carried out to study the influence of steel fiber reinforcement on the stress–strain behavior of concrete made with CDW aggregates.He concluded that the utilisation of recycled aggregate in substitution of natural aggregate increased the compressive, bending and tensile strength of the reference mixture. The inclusion of steel fiber and recycled aggregate increased all mechanical properties of the CDW-concrete and better controlled its fracture process. Further, a comparison between the analytical and experimental curves demonstrates that they are in good agreement indicating the possibility of their use to model the behavior of steel fiber-recycled aggregate concrete.

Xiaoliang Fang has investigated that in order to analyses the potential CO2 capture ability of recycled concrete aggregates (RCAs) subjected to accelerated carbonation, an empirical

prediction model has been developed in relation to carbonation conditions and the characteristics of RCAs. In this research, two sources of RCAs were used: RCAs from a designed concrete mixture and RCAs obtained from crushing of old laboratory concrete cubes. He concluded that the maximum CO2 uptake of RCAs during accelerated carbonation depended mainly on the cement content as well as the initial CO2 uptake ratio (X0CO2). The particle size of RCAs played a significant role in affecting the cement content and the rate of CO2 uptake. The relative humidity (RH) during accelerated carbonation process was significant. Further, the developed empirical model may well predict the CO2 uptake of the RCAs from newly demolished concrete waste.

Sun-Woo Kim has described pullout test results on deformed reinforcing bars in natural and recycled fine aggregate (RFA) concrete. The effects of bar location and RFA grade on bond strength between reinforcing bar and recycled aggregate concrete (RAC) were analysed through the experimental program. He concluded that for higher grades of RFA, bond strength did not seem to be influenced by RFAr, at least for up to 60% RFAr. It can be noted that the location factor is influenced by the workability of concrete. Based on the cross-sections of all specimens after pullout tests, no significant differences were obtained in the amount of concrete segregation and settlement. Further, based on the RDM, no important freeze–thaw deterioration in concrete was detected after 300 freeze–thaw cycles in RAC specimens due to their relatively high air contents.

George Wardeh has presented the results of an experimental program carried out on 96 concrete pullout specimens prepared with natural and recycled aggregates using 10 and 12 mm diameter deformed steel bars. The study included six recycled concrete aggregate mixtures and two conventional concrete mixtures with C25/30 and C35/45 target class of compressive strength and S4 class of workability. He concluded that the bond strength of recycled aggregate concrete remains of the same order magnitude as that found for the reference normal concrete. In all cases, the evaluated values are equal to the values calculated by the formula of EC2 without safety factors and are therefore at least four times higher than the predicted values. Further, based on experimental results and data withdrawn from the literature, a modified expression was proposed to find the maximum bond stress of the recycled concretes taking into account the effect of concrete cover, the embedded length, and the replacement ratio.

Fuxing Wang has reported that recycled aggregates from construction and demolition waste after crushing, washing and grading which replace partly or all of the natural aggregates are reutilizable to form new concrete. Compared with natural aggregate concrete, mechanical performance and durability of recycled concrete are worse. The reason may be that the recycled aggregate (RFA) is formed of original aggregate and old cement adhering outer partly. In this paper, the superficial modification of recycled fine aggregate using fly ash grout, the physical attributes of RFA before and after modification and the effect on the mechanical performance of cement mortar were studied.

Wenlao Zhao has studied the use of recycled fine concrete and clay brick aggregates to respectively globally replace natural fine aggregates (sand) in the production of mixed mortar. The fundamental attributes such as the compressive strength and the shrinkage ratio of mixed mortar made of the recycled fine aggregates are tested and discussed in detail. The experimental results show that it is viable to produce mixed with recycled fine aggregate.

Joris Schoon has investigated with the aim to examine the use of fines generated out of recycled aggregates production as an alternative raw material for Portland clinker kilns with enumeration of possible limitations. Different technical set-ups were utilised to separate these fines from the recycled aggregates. In this research, it was shown that the fines fractions generated out of concrete recycling could be used as an alternative raw material (ARM) for Portland clinker production. However, a homogenisation phase adapted to the chemical variation of the recycled fines will be important. It was shown that the smaller the fines fractions are cut from the sand fraction, the better they are suited as ARM for Portland clinker production. The way these fines fractions are separated also affects the final quality of the treated sand fraction and therefore also its practical use in concrete as well as asphalt applications. Further, the use of fines extracted from recycled concrete focuses on some of the key issues identified within the Cement Sustainability Initiative, together with the already available alternative fuels and raw materials.

J.Alexandre Bogas has carried out the investigation to characterize the freezeethaw resistance of normal strength and high-strength concrete with partial or total replacement of fine natural aggregate (FNA) by fine recycled concrete aggregate (FRCA). The surface scaling, mass loss, length change, residual ultrasound pulse velocity and residual compressive strength were analysed for different FRCA replacement ratios (0%, 20%, 50% and 100%) subjected to 300 freezeethaw cycles according to ASTM C666 e Porches concluded that normal strength concrete was not freezeethaw resistant, regardless of the replacement rate of FNA with FRCA; the freezeethaw resistance was more influenced by the w/c ratio than by the type of aggregate used. Surface scaling appears to be more severe in concrete with FRCA, because its mortar is less resistant. In general, the internal freezeethaw resistance of concrete did not decrease with the inclusion of FRCA; the higher porosity of FRCA may better contribute to hydraulic pressure dissipation. In sum, FRCA appeared to be non-detrimental to the freezeethaw internal cracking resistance of concrete. Further, FRCA proved to be non-detrimental to the freezeethaw internal cracking resistance of concrete.

Siti Shahidah Sharipudin has made the attempt that has been placed on replacing the main ingredients in concrete mixtures with more sustainable materials with the objective to reduce the carbon footprint. One of the replacement materials is waste paper sludge ash (WPSA), a local industrial by-product produced abundantly by newsprint mills which possesses considerable cementitious properties. Parallel to this, the high amount of construction waste, especially concrete waste has become a difficult environmental issue to cope with in today's world. In conclusion, the replacing proportion of cement and fine aggregate with WPSA and FRCA up to 20% and 15% respectively contribute towards compressive strength by blending

of WPSA and FRCA, exhibited favorable and equivalent compressive strength than those of control specimens. In this case, the alkalis released from the residual paste in FRCA together with cementitious reaction presence in the latter could be attributed to strength development.

Hawreen Ahmed has presented the effects of using supplementary cementing materials and recycled concrete aggregates (RCA) in concrete, with emphasis on the ability of using high volumes of fly ash (FA) and RCA to reduce the environmental impacts of the concrete's production process without jeopardizing most of its long-term durability characteristics. Three mix families (0% fine RCA, 50% fine RCA and100% fine RCA) were prepared and, for each of these three families, two incorporation levels (0% and 100%) of coarse RCA were used with 0%, 30% and 60% of FA without SP. In this research the w/b ratio of the concrete mixes was changed in order to maintain the workability of an equivalent conventional concrete. The worst-case scenario is obtained when fine NA were half or fully replaced with fine RCA, either with or without inclusion of coarse Scathe best-case scenario was obtained when the coarse NA were fully replaced with coarse RCA and 60% of FA included in concrete mixes with SP.The inclusion of coarse RCA only shows better performance than that of fine RCA.Including FA in RCA concrete is advisable. However, for the combined effect of FA and RCA, the compressive strength-GWP ratio depends on optimizing the proportion of FA versus RCA rather than on their individual contents.

Junxia Li has carried out the research to investigate potential use of RCF as microsilica sand substitute in the production of engineered cementitious composites (ECC), a unique high performance fiber-reinforced cementitious composites featuring extreme tensile strain capacity of several percent. The results indicated that it is viable to use RCF as microsilica sand substitute in the production of ECC and the resulting RCF-ECCs possess decent compressive strength and strain capacity. The results clearly analysed the influence of RCF size and content on ECC properties. Micromechanics-based design principle can be utilised for ingredients selection and component tailoring of RCF-ECCs.

D.Pedro has carried out the analysis of the mechanical behaviour of high-performance concrete (HPC) incorporating fine and coarse recycled aggregates (FRA and CRA) was made. The recycled aggregates (RA) originated from rejected precast elements with compressive strengths of 75 MPa and were used to substitute natural aggregates (NA) in concrete mixes.To conclude, in the fresh state, it was possible for recycled HPC to have similar workability as that of the reference HPC (produced with natural aggregates only). In the hardened state, despite the decrease in performance of the RAC relative to the RC, extremely satisfactory values were obtained, which were further increased with the presence of SF. For the modulus of elasticity, it was found that the highest value recorded by a mix incorporating 100% RA was around 41GPa (C100F100C-SF10). Finally, for bond strength, only a few concrete mixes were analysed.

Abdurrahmann Lotfy has presented the fresh, mechanical, and durability performance of a structural concrete mix classified as a C1 mix, by the Canadian Standards Association (CSA) made with Controlled quality Recycled Concrete Aggregate (RCA). Seven mixes with water-

to-binder (w/b) ratio of 0.40 and RCA content of 10%, 20%, and 30% by coarse aggregate volume replacement, 10%,

and 20% fine and coarse (granular) aggregate replacement by volume were produced and tested against two 0% RCA control mixes made with General Use (GU) cement, and General use Limestone cement (GUL), respectively. To conclude, using a controlled quality RCA as a replacement for virgin aggregates produced a concrete that met specifications and performed similarly to the control. All mixes showed similar slump and air content values after 15 minutes, and the control mix had the best retention after 45 minutes. However, the slump and air content for the RAC mixes did not vary greatly from the control, indicating that a 30% replacement of virgin aggregates with RCAs is a viable option. The splitting tensile strength results indicated a similar trend to the flexural strength results. The splitting tensile strength reduced as the replacement level of RCA increased. According to the control concrete, replacement of RCA by natural aggregate slightly increased water sorptivity, and chloride-ion permeability values. Moreover, the RCA mixes with more RCA resulted in higher water sorptivity and chloride-ion permeability values. In summary, the utilisation of a controlled quality RCA in structural concrete is a safe and viable option.

MATERIALS CHARACTERIZATION

A. CEMENT: Ordinary Portland cement 43 (OPC 43) was used in this study. The chemical ingredient are exist in this type of cement which are given in the table below

S. No.	ingredient	Percentage (%)
1.	Calcium oxide (CaO)	66.00
2.	Silica (SiO_2)	23.13
3.	Iron oxide (Fe_2O_3)	3.51
4.	Aluminum oxide (Al_2O_3)	4.41
5.	Sulfur trioxide (SO_3)	0.89
6.	Magnesium oxide (MgO)	0.78
7.	Others	1.27

B. AGGREGATE: Recycled fine aggregate are used in this study which are obtained from concrete waste, collected from the demolished buildings in area of Delhi.

CONCLUSIONS

To achieve the same fluidity as controlled mortar, RFAM requires more water. Recycled aggregate mortar's setting time is affected by its fluidity and RFA content. Time increases the RFAM's resistance to penetration thanks to the fluidity and RFA concentration. Quicker than

controlled mortar, RFAM eventually became stable. The mechanical properties of RFAM are inferior to those of controlled mortar, as are its UPV, chemically bound water, and void content; however, its permeability is improved. Compared to controlled mortar,

ateriRFAM have more immersion water absorption and sorptivity. No matter how well they speak it. As fluidity changed, so did the mechanical and permeation performance of RFAM. [Cite] When compared to its fluidity at 1102.5 mm, the mechanical and permeability properties of RFAM diminish with increasing RFA content. Increases in RFA concentration lead to notable improvements in mechanical and permeation properties when RFAM fluidity is raised from 1102.5 mm to 1352.5 mm. The mechanical and permeability properties of RFAM dramatically degraded when its fluidity increased from 135 2.5 mm to 160 2.5 mm. As a result, fluidity may improve RFAM efficiency, which in turn lowers the inherent variability in RFA quality.

REFERENCES

[1] Rattapon Somna, Chai Jaturapitakkul, A.M.ASCE, Wichian Chalee and Pokpong Rattanachu 2012, "Effect of the Water to Binder Ratio and Ground Fly Ash on Properties of Recycled Aggregate Concrete". ASCE
[2] MostafaTavakoli and ParvizSoroushin, Strength of recycled aggregate concrete made using field demolished concrete as aggregate, ACIMaterial Journal, volume 93, pp 182 – 190-1996.
[3] De-jian YANG, Ya-han HAO and Tie-cheng W 2010, "Experimental Research on Recycled Aggregate Concrete for Highway Pavement". ASCE.
[4] Soutsos M. N., Tang K. and Millard S. G., (2010) "Concrete building blocks made with recycled demolition aggregate", Construction and Building Materials, Vol. 25, No. 2, pp726–735.
[5] Thomas C., Setién J., Polanco J. A., Alaejos P. and de Juan M. S., (2013) "Durability of recycled aggregate concrete", Construction and Building Mals, Vol. 40, pp1054–1065.
[6] Viviana Letelier, Ester Tarela , Pedro Munozb, Giacomo Moriconi 2016, "Combined effects of recycled hydrated cement and recycled aggregates on the mechanical properties of concrete". Science Direct
[7] Verma Ajay, Chandak Rajeev and Yadav R.K. 2012, "Effect of Micro Silica on The Strength of Concrete with Ordinary Portland Cement," IJSR Vol. 1(3), 1-4, Sept
[8] Rammurthy and GumasteProperties of recycled aggregate concrete, Indian Concrete Journal, volume 72, pp 49 – 53-1998.

CHAPTER-5.11

Experiments and Surveys Concerning Civil Instruments, As Well As Research on Those Instruments

Dr. Sanjeev Gill
H.O.D, Department of Civil Engineering, JB Institute of Technology, Dehradun, India, 248197
hodcivil2017@gmail.com

ABSTRACT- *Surveying knowledge is helpful in many areas of civil engineering. A lot of the first surveys were done for the purpose of land surveying. Water supply and irrigation schemes, roads, railroads, transmission lines, mines, buildings, and bridges all need to be surveyed before any plans or estimates can be made. A horizontal projection of an area, such as that used by plans and maps, simply reveals the vertical separation between points. Nevertheless, a contour line is used to depict the vertical distances between two points. All points have been fully specified, and a levelling network has been constructed. A theodolite tape measure & wheels (steel tape) and a stave were used to measure a variety of parameters, including horizontal distance, horizontal angles, and elevation differences, between all points in a series of closed levelling loops (levelling rod). They fed the data into a mathematical model and ran it through some sort of traverse adjustment procedure. An accurate and comprehensive survey is crucial to the success of any engineering project. As a result, it is essential for an engineer to have a solid grounding in surveying theory and methodology.*

Keywords- horizontal distance, Chain; Compass; Level, Classifications surveying.

INTRODUCTION

Surveying is an art form that involves identifying the relative position of items on the surface of the earth by taking measurements and drawing them to a handy reduced size on paper. This is done in order to make the process more efficient. Both geodetic surveying and plane surveying are included in this category. The spherical shape of the earth is taken into account in the construction of this categorization. We are aware that the form of the earth is that of a hemisphere. How do you plan to demonstrate that? If we were to stand on the ground, we would be able to view anything in the same line of sight. This would indicate that we are standing on a flat earth. People in former times believed the same thing, and they were afraid to travel too far away because they believed that once they reached the limit or the edge, they would be forced to fall off. What is the significance of the shape in relation to the surveying? Sure enough, here it is. The human eye perceives the line that connects any two spots on earth to be straight, yet in actuality, the line that connects any two points is curved. It is referred to as plane surveying when the measurements are taken without taking into account the influence of the earth's curvature. When the influence of the earth's curvature is taken into consideration, the surveying technique is referred to as geodetic surveying. It is possible to ascertain the topography, or gradient, of the land that is farmed, as well as the absolute and relative positions of points both on the farm and on the surface of the planet. Farmland surveying can be used for a variety of purposes, including environmental feasibility assessments, as well as providing the farmer with the ability to make effective use of the land. Because the findings of the survey, whether they are presented graphically or numerically,

help to describe the characteristics and properties of the various soil units, these findings are helpful.

TYPES OF MEASURMENTS IN SURVEYING

There are five basic kinds of measurements in plane surveying:

- Horizontal angles
- Horizontal distance
- Vertical angles
- Vertical distance
- Slope distance

Classification of surveying: Surveys may be classified under headings which define the use or purpose of the resulting maps.

Based upon the nature:

(A) Land survey
- Cadastral survey
- Topographical survey
- City survey

(B) Hydro graphic survey

(C) Astronomical survey

Based upon the object:

- Engineering survey
- Military survey
- Mine survey
- Geological survey
- Archaeological survey

Based upon the instruments:

- Triangulation survey
- Aerial survey
- Chain Surveying
- Plane Table Surveying
- Levelling
- Theodolite Surveying
- Tachometric Surveying
- Photographic Surveying
- Compass Surveying

Chain surveying: It is the method of surveying in which the area is divided into net work of triangles and the sides of the various triangle are measured directly in the field with chain and no angular measurement are taken.

Instrument used in chain survey:

- Chain
- Arrows

• Pegs
• Ranging rods
• Offset rods
• Plasterer laths and whites
• Plumb bobs
• Field book

Types of chain:

• Metric chain
• Engineer's chain
• Gunter chain
• Revenue chain
• Steel band

Errors in chaining:

• Errors length of chain
• Careless holding and marking
• Bad ranging
• Non-horizontality
• Sag in chain
• Variation in temperature
• Variation in pull
• Personal mistakes

Tape corrections:

• Correction for temperature
• Correction for Length
• Correction for Pull
• Correction for Sag
• Correction for Slope
• Correction for Alignment
• Reduction to sea level
• Correction to measurement in vertical plane

Obstacles in chaining:

• Obstacles to ranging
• Obstacles to chaining
• Obstacles to both chaining and ranging

Compass Surveying-compass surveying is a branch of surveying in which direction of survey lines are determined with a compass and length of the lines are measured with a tape or a chain. In practice the compass is generally used to run a traverse.

Types of compasses:

• Prismatic compass
• Surveyor compass

Bearing and angle

• True meridian
• Magnetic meridian
• Arbitrary meridian

Designation of bearing

• Whole circle bearing
• Quadrant bearing
• Fore bearing
• Back bearing

Conversion of bearing from one system to other

Line	WCB	Rule for R. B.	Quadrant
AB	0° - 90°	R.B=WCB	NE
AC	90°-180°	RB=180°-WCB	SE
AD	180°-270°	RB=WCB-180°	SW
AF	270°-360°	RB=360-WCB	NW

Conversion of into WCB

Line	R. B.	Rule for WCB	WCB
AB	N α E	WCB=RB	0° - 90°
AC	S ß E	WCB=180°-RB	90°-180°
AD	S ɵ W	WCB=180°+RB	180°-270°
AF	N Ø W	WCB=360-RB	270°-360°

Local Attraction: It is a term used to denote any influence of iron objects like magnetite in the ground, wire carrying electric current, steel structures, rail road rails, underground iron pipes, bunch of keys, metal buttons, axes etc., and preventing the magnetic needle from pointing to the North in a given locality. This should be checked and corrected.

Dip: The inclination of the magnetic needle in the vertical direction is called Dip. It is 0˚ at Equator and 90˚ at the Poles.

Magnetic Declination: It is the angle between the True Meridian and Magnetic Meridian. With the given value of Magnetic Bearing we can find the True Bearing and vise versa. List the errors in a compass Instrument.

The errors may be caused due to:

• needle not straight
• pivot not upright
• needle lost magnetism
• pivot not sharp but dull
• movement of the needle not free
• plane of sight not vertical
• graduation circle not horizontal
• Plane of sight not passing through the graduated ring.
• vertical hair is too thick or low

Levelling: It is a means by which surveyors can determine the elevation of points, using other known points as references. Levelling is perhaps the most basic of surveying operations and forms an important fundamental part of almost every surveying project.

Methods of levelling:
• Barometric levelling
• Trigonometric levelling
• Spirit levelling
• Reciprocal levelling
• Profile levelling
• Differential

Levelling instruments:
• Dumpy level
• Wye level
• Auto level
• Reversible level
• Tilting level
• Digital levels
• Laser levels

Adjustment of level:
• Centring
• Levelling
• Focussing

Some important technical terms:
• Bench mark
• Mean Sea Level
• Reduced Level
• Back Sight
• Fore Sight
• Inter sight
• Change point

Booking and reducing levels:

• Collimation or height of instrument method
• Rise and fall methods

st	B.S	I.S	F.S	H.I	R.L	RE
A	0.865			561.36	560.50	BM
B	1.025		2.105	560.285	559.260	
C		1.58			558.705	
D	2.230		1.865	560.650	558.420	
E	2.355		2.835	560.270	557.815	
F			1.70		558.410	
Check	6.475		8.565 6.475		558.410 560.500	
			2.090		2.090	

Arithmetic check = ΣB.S-ΣF.S = Last R.L – Ist R.L

Σ8.565-Σ6.475 = Σ558.410-Σ560.500

2.090 = 2.090

Uses of Levelling:
• It is used in drawing the contours.
• It is useful in drawing the longitudinal sections and Traverse sections
• Levelling is mainly used to calculate R.L.s of various stations.
• It is very useful in area and volume calculations

Plane Table Surveying: Plane table surveying also known as plane tabling is a method of surveying in which field work and is done simultaneously on a plane table. The observations are taken and recorded side by side on the sheet fixed upon the plane table and map of the area is obtained.

Equipment used in plane table:
Drawing board
Tripod stand
Alidade
Accessories
• U-frame
• Spirit level

• Plumb bob
• Trough compass

Methods of plane table surveying:

• Radiation
• Intersection
• Traversing
• Resection

Advantages:

• It is less costly than theodolite survey
• Notes of measurements are seldom required and the possibility of mistakes in booking is eliminated.
• It is particularly useful in magnetic areas where compass cannot be used.
• It is simple and hence cheaper than Theodolite or any other type of surveying.
• It is most suitable for small scale maps.
• No great skill is required to produce a satisfactory map and the work can be entrusted to a subordinate
• Plan is drawn by the out-door Surveyor himself while the country is before his eyes, and therefore, there no possibility of omitting the necessary measurement.
• The Surveyor can compare plotted work with the actual features of the area.
• Since the area is in view, contour and irregular object may be represented accurately.
• Direct measurements may be almost entirely dispensed with, as the linear and angular dimensions are both to be obtained by graphical means.

Disadvantages:

• It is unsuitable for work in a wet climate and is difficult in high wind.
• It is most inconvenient to use this instrument.
• Due to heaviness it is difficult to transport.
• Since there are so many accessories, there is every likelihood of these being lost.
• Since notes of measurements are not recoded, it is a great inconvenience if the map is required to reproduce to some different scale.
• The Plane Table is not intended to very accurate work.
• It is essentially a tropical instrument

Theodolite Surveying: The theodolite is the most precise instrument designed for the measurement of horizontal and vertical angle and has wide applicability in surveying such as laying off horizontal angle locating points online prolonging survey line establishing grades, determining difference in elevation, setting out curve.

Types of theodolite:

• Transit theodolite
• Non-transit theodolite

Adjustment of theodolite:

• Setting over the station

• Levelling up
• Elimination parallax

Measurements:

• Horizontal angles
• Vertical angles

Electromagnetic distance measurement:

• A reflector or transmitter-receiver at the far end reflects the light of microwave back to the instrument where they are analyzed electronically to give the distance between the two points.
• Modern EDMs, referred to as total station instruments display horizontal and vertical distances between the ends of the line and horizontal and vertical angles to a survey point.
• Recently some EDM instruments have been introduced that do not require reflectors for distance measurement. These devices can measure distance up to 100 m in length.

CONCLUSION

This research paper provides a concise explanation of the surveying instruments used in civil engineering. These instruments are put to use in specific circumstances and have the ability to resolve any issue pertaining to civil engineering site activities. It teaches one how to operate all of the surveying tools, which is information that can be useful for both theoretical and practical applications.

REFERENCES

[1] Chandra, A.M. “Higher Surveying”, New Age International Publishers, Delhi
[2] Surveying - Higher Surveying by B.C .Punmia & Ashok Jain – Vol.III
[3] Basic Civil Engineering – Dr. B.C punmia & Ashok Kumar Jain & Arun Kumar Jain – Page 185
[4] Surveying and Levelling by Punmia
[5] surveying by C.L.Kocher vol. I
[6] B.C Punmia, Surveying, Lakshmi Publ. 1994.
[7] Arora, K.R., “Surveying”, Vol. I & II Standard Book House, Delhi,
[8] T .P. Kanetkar & S. V, Kulkarni, Surveying and Levelling Part I and II Pune Vidhyarthi Griha Prakashan
[9] Chandra, A.M. “Plane Surveying”, New Age International Publishers, Delhi
[10] Kennie, T.J.M. and Petrie, G., “Engineering Surveying Technology”, Blackie & Sons Ltd., London, 1990.
[11] N.N.BASAK, Surveying and Leveling, Tata McGraw-Hill
[12] A. M. Chandra, Plane Surveying, New Age International Publishers.

CHAPTER-5.12

Installed Buildings Use of Water Proofing Materials

Bhaskar Singhal[1], Dr. Sanjeev Gill[2]
[1]Assistant Professor, Department of Civil Engineering, JB Institute of Technology, Dehradun, India, 248197
[2]H.O.D, Department of Civil Engineering, JB Institute of Technology, Dehradun, India, 248197
bhaskarsinghal3045@gmail.com

ABSTRACT- *Drawings, scales, quality control, building, and proper maintenance are some of the components that make up a man-made structure. These components are employed to support the many various benefits that human society offers. Before demolishing the building, it is imperative that the level of construction be handled, as it is both a significant factor and an important duty that needs to be avoided. Water issues are sneaky killers and play a key influence in the process of maintaining and preserving the building. Capillary movement allows water to go great distances through the stone or concrete that makes up the floor of the basement. It is possible for water to seep into the ground at any point; the likelihood of this happening is determined by the strength of the concrete and how full the outside surface is. Each structure is eligible for selection because, in addition to addressing the care issues involved, it focuses on natural resource management. A significant contributor to the deterioration or damage that can be caused to a structure is water. Because water can be destructive, careful consideration ought to be given to the selection of water-resistant materials of the highest possible quality in order to achieve the best possible results. The lifespan of water-resistant materials is significantly less than the lifespan of the structure they are used in. This article discusses the application of waterproofing materials and outlines the various kinds of waterproofing materials that are typically put to use.*

Keywords: Water resistant material, harmful capillary movement, water proofing material.

INTRODUCTION- Waterproofing keeps water out of buildings. It creates an impenetrable barrier on foundations, roofs, walls, and other building components. Structures are sometimes watertight. Layers and portions of waterproofing prevent water from entering the building. It keeps buildings dry. It also shields the structure. Damage caused by moisture and water exposure. The building is waterproofed through membranes and holes to protect the contents of the floor or inside and to protect the integrity of the building. A combination of such categories is referred to as creating a “Building Envelope”. Therefore, the compatibility of the materials, their interaction, and the connection of the enclosed spaces of the buildings also judged the performance of the structure. And this performance is greatly hampered by external climatic factors, where rainwater and site flow play a major role. Therefore, protection from the weather, seepages from the ground and direct flow of water into the building can be effectively protected by the proper use of a waterproofing system.

Modern water protection systems deal with stable structures with a dual course in its operation at the well. Various and specific coats with specific chemical concentrations allow the process to perform many functions easily. The same energy saving effect occurs due to the use of materials involved in this process. This includes coatings on the exterior and floor walls, which reduces the flow of heat to the building and thus reduces the burden of improving indoor air quality and space atmosphere. Waterproofing systems can also be

referred to as "building protection and renovation" or "renewable engineering", due to their versatility and value. Waterproofing is not only a big part of the building process but also preserves the dignity of the landscape. (Grading here means extensively identifying, controlling and improving the area for proper construction). Therefore, the waterproofing system applies not only to the entire construction envelope, but also to certain parts of the building.

The Importance of Water Tightness: A building, in a sense, is a living organism that requires attention and care just like any other living thing. Water and moisture issues should be avoided as well. The following are examples of the kinds of damage that can be caused by water leaks in a building. One method of seepage is the use of a variety of wall attachments; sills, extensions, brickwork joints, etc.Secondly, the basement and the basement absorb groundwater. Third, a pipe explosion in the wall or underneath the floor.

Fourth, the capillaries protrude through the brickwork, the mortar, and the pillars.

When does a building have a water proofing issue, and how can you tell?

Make sure we have a waterproofing problem if there are any obvious symptoms in the structure.

• The walls are drenched and the floor is soaked
• Developing a fungal or bacterial growth The Telltale Symptoms of Decay
• Water-Mixing
• Water seepage through the roof.

Any of these issues can ruin a building's appearance, interior, and even its foundation...One advantage of waterproofing is that it ensures the building remains dry and sturdy. Two, the humidity inside the building is decreased, making it a more pleasant place to live. Third, water vapors and condensation don't harm anything. Strong and long-lasting construction.

The Many Waterproofing Materials: Thinking about your house as if you were picking out a waterproof coating is crucial. Thus, it is important to research and comprehend the various waterproofing materials available for the structure in question.

Polyurethane

As such, it serves as a roof's water barrier. The liquid polyurethane membrane's adaptability comes with several advantages, including (but not limited to) the following:

1. sealing capillary cracks.
2. Concrete water absorption should be minimized.
3. Liquid fortifies the concrete's outer layer.

Application Areas:

• Water tanks
• Pedestrian stairs
• The roof

• Bridges
• Parking area

Cementations Waterproof Coating: This app provides a very simple program. The mixture contains sand, silica, organic chemicals, and inorganic chemicals. Also, these substances are combined with the function of lime as a sealant.

Application Areas:
• Water treatment plants
• Ports and harbors
• Parking area
• Channels

Bituminous Waterproof Membrane: Also known as bituminous coating, or asphalt coating, this membrane works effectively against water infiltration. Bituminous is mixed with natural adhesives. Therefore, its viscous quality makes it a very strong waterproofing material for the roof.

There are two ways to use bituminous:

1. Roll roofing material method
2. Roofing felt method

EPDM Rubber: This waterproofing material is a synthetic rubber material made of propylene and ethylene. Typically, experts associate an EPDM rubber solution with a silicone compound. However, both vary depending on the chemical composition, use, and characteristics.

Also, EPDM rubber is highly adaptable and recyclable.

Application Areas:
• The roof
• Windows
• Wood

Rubberized Asphalt: Another excellent waterproof chemical, Rubberized Asphalt works effectively to protect buildings. The strength, flexibility, and resistance to moisture and the penetration of this vapor make it extremely durable and suitable for structural treatment.

Application Areas:

• The roof
• Plazas
• Parking spaces
• Terrace

Thermoplastic Waterproofing: One of the most effective waterproof materials is thermoplastic. This solid solution provides long-term protection in buildings. Therefore, its anti-inflammatory factor makes it suitable for all heavy treatments.

Application Areas:

• Decks
• Elevator pits
• Fountains

PVC Membrane: This feature is often used to prevent water from roofing. Its vapor-permeable material gives it extra strength. The base of the PVC membrane uses polyester mesh or glass fiber.

Application Areas:

• The roof
• Tunnels
• Swimming pools
• Underground structures

Waterproofing paints: Waterproof paint protects the house from environmental damage and improves the health of the building. Therefore, it remains water resistant or completely waterproof. Waterproof paint can be used inside buildings in bathrooms, kitchens, basements, etc. Therefore, it could protect the bathroom and the basement from leaks and excess moisture. The waterproof paint bathroom wall prevents moisture from entering the walls. Therefore, these paints are preferred over conventional paints as the first one will not stand firm against wet conditions as before. In addition, once moisture has penetrated the walls, mold and mildew will damage the structure and cause health problems.

Types of Waterproofing Paint:

Epoxy Paint for Waterproofing: Epoxy waterproof paints use strong chemicals to combat very wet conditions and protect the surface. They make waterproof paint on roofs and water-repellent paints.

Masonry Waterproof Paint: Made of a mixture of latex and ceramic paint, waterproof masonry paint is often used for roofing. Also, this paint absorbs chemicals and other liquids easily like water and prevents them from getting inside. It also provides cement with waterproof chemicals.

Acrylic Waterproof Paint: This type of paint is best suited for roofs and terraces made of rectangular blocks. Also, this paint on the roof and the balcony harmonizes and drains the water on the surface. Additionally, waterproof paint is non-toxic and easy to apply.

PROCESS OF WATERPROOFING

Waterproofing is done horizontally, above the structure, retaining respiratory equipment, to prevent the flow of water and the rise of capillary water in it. The interior displays the water content of the structure and externally forms a protective film around it. Typically, the construction of a waterproofing system is done by creating many barriers to stop the ingress of water, so that it cannot enter the building. This development of multiple layers, materials and methods in them creates a kind of "envelope" of structure around the building. This

envelope can be treated as a permanent feature or measure of a green structure by avoiding the ingress of excessive heat from the atmosphere. This can be done by applying various paints, adhesives and other finishes as well as blending that helps create a transition between outside and inside temperatures. This transition between temperatures helps the structure in the following ways:

• Small differences between indoor and outdoor temperatures cause minor weather symptoms and protect the building. This is done in such a way that the effect of compaction or expansion during the various seasons in the material construction of the building is reduced, by matching the room temperature with the external temperature.

• Reduce the burden on the HVAC system, and other procedures that a building occupant often uses to keep the room temperature stable. These reductions can best be attributed to energy savings, drinking water consumption and other utilization of resources. This usually moves the building to a green place.

TYPES OF WATERPROOFING METHODS:

There are some common types of waterproofing methods used in construction industry. Waterproofing in buildings/structures is generally required for:

• Basement of structure
• Walls
• Bathrooms and kitchen
• Balconies, decks
• Terrace or roofs
• Green roofs
• Water tanks
• Swimming pools

The following waterproofing methods are commonly used in construction:

1. Cementitious Waterproofing
2. Liquid Waterproofing Membrane
3. Bituminous Membrane
4. Bituminous Coating
5. Polyurethane Liquid Membrane

1. CEMENTITIOUS WATERPROOFING METHOD:

Cementitious waterproofing is an easy way to prevent water from forming. Cement waterproofing materials are readily available in the market. This method is often used in wet indoor areas such as toilets. This method is usually a solid or flexible type that prevents water, but as it is used in indoor areas such as toilets, it is not exposed to sunlight and weather. Therefore, waterproofing with cement does not exceed the contract and the expansion process.

APPLICATIONS OF CEMENTITIOUS WATERPROOFING:

Cementitious waterproofing is used in the following type of structures:

1. Water Treatment Plants
2. Sewage Treatment Plants
3. Bridges
4. Dams
5. Railway & Subway Systems
6. Marine Cargo Ports & Docks
7. River Locks/Channels & Concrete Dykes
8. Parking Structures & Lots
9. Tunnels

2. LIQUID WATERPROOFING MEMBRANE METHOD:

Liquid membrane is a thin layer that usually includes the first coat and two coats of top coat used with a spray, roller, or trowel. It offers more flexibility than cementitious types of waterproofing. The liquid heals into a rubber wall. The elongation properties of coating can reach as high as 275%. The durability of a waterproof coat depends on the type of polymer the manufacturer uses to make the liquid waterproofing.

A waterproof membrane can be a liquid-coated liquid coated with polymer-modified asphalt. Polyurethane liquid membranes for different levels of trowel, roller, or spray are also available from various manufacturers.

3. BITUMINOUS COATING WATERPROOFING METHOD:

Bituminous coating is a type of coating used for waterproofing and flexible protective coat according to its composition and polymerization stage. Its flexibility and water protection can be influenced by the polymer level and fiber reinforcement. Bituminous coating is also called asphalt coating. The most common applications for bituminous coatings include areas under wet screed. It is an excellent protective agent and waterproofing agent, especially in areas such as concrete foundations. Bituminous coating is made of bitumen-based materials and is not suitable for exposure to the sun. They become very brittle and weak when exposed to prolonged exposure to the sun unless they are prepared with flexible materials such as polyurethane or acrylic-based polymers. The flexibility of the finished products always depends on the solid polymer content added to the bitumen.

4. BITUMINOUS MEMBRANE WATERPROOFING METHOD:

Waterproofing of bituminous membranes is a popular method used for low-grade roofing due to their guaranteed performance. Bituminous membrane waterproofing has a flashlight on the lining and adhesive membranes. Adhesive composites include asphalt, polymers and fillers; in addition, certain resins and oils may be added to improve adhesion properties. The self-adhesive type has a lower shelf life as membrane binding structures shrink over time. The torch on the membrane is exposed and covered with types. Exposed membranes usually

contain granular mineral aggregate to withstand the aging and degradation of the weather and other types of membrane, the contractor needs to install a single protective screed to prevent membrane perforations.

5. POLYURETHANE LIQUID MEMBRANE WATERPROOFING METHOD:

The polyurethane liquid membrane waterproofing method is used for the flat roof area and is weatherproof. This method of waterproofing is expensive. The Polyurethane Liquid Membrane can provide high flexibility. Polyurethane is very sensitive to existing moisture, so before installing, one should be very careful checking the moisture content of the concrete slab, otherwise peeling or cracking of the membrane may occur after some time.

CONCLUSION

The consequences of water damage to a structure can be devastating. Damage to the building's foundations, structural instability, and personal belongings are all possible results of water intrusion. As quickly as wood rots when exposed to water, concrete and other construction materials can be damaged by water infiltration, especially in colder climates where water can freeze and cause fissures. Inadequate waterproofing isn't simply an issue during the rainy season; it may be a problem all year long. Buildings should have some level of permeability so that humidity produced by occupants can be safely ventilated outside. Waterproofing a structure involves taking measures to reduce the likelihood of water getting inside and then ensuring that any water that does get inside has nowhere to pool or collect.

REFERENCE

[1] Absorption of concrete surface'. vol.2, pp.38-45.
[2] T.Subramani, a.Anbuchezian.(2017)'water proofing concrete by using fake snow powder' vol.6, pp.2319-4847.
[3] Abhishek G H, lokesh J K. (2016) 'evaluation of different kinds of integral water proofing compounds as per IS codes' vol.5, 2219-8753.
[4] Annu baby, Jeena Mathew. (2016) 'studies on properties of concrete with various waterproofing compounds'vol.21, 2278-1684.
[5] Saurabh borle, gadget (2016) 'comparative study of conventional and morden water proofing techniques', Volume: 5 Issue: 1, pp. 32-36.
[6] Richard Pkadlubowski AiA. (2010) 'water proofing' Vol. 27.
[7] A.Geetha P.perumal (2011) 'chemical reaction of waterproofing admixtures on the corrosion behavior of reinforced cement concrete' (2014), pp. 407-411.
[8] Dhiren J Panchal Nehal H shah 'water proofing challenges and suggested temedial measures for high rise buildings' (2015) vol-10.
[9] Li Jiye, construction quality problems and prevention measures [M]. China Building Materials Industry Press.2003.

CHAPTER-5.13

To Study Cellular Light Weight Concrete

Bhaskar Singhal[1], Dr. Sanjeev Gill[2]
[1]Assistant Professor, Department of Civil Engineering, JB Institute of Technology, Dehradun
[2]H.O.D, Department of Civil Engineering, JB Institute of Technology, Dehradun
bhaskarsinghal3045@gmail.com

ABSTRACT: *Cellular Light weight Concrete (CLWC) is not an invention in concrete world. It has been known since ancient times. It was made by using natural aggregates of volcanic origin such as pumice, scoria, etc. The Greeks and the Romans used pumice in building construction. Lightweight concrete can be defined as a type of concrete which includes an expanding agent in that it increases the volume of the mixture while giving the additional qualities such as inability and lessened in the dead weight. The usage of Cellular Light-weight Concrete (CLC) blocks gives a prospective solution to building construction industry along with environmental preservation.*

INTRODUCTION

Concrete is the most important construction material. Concrete is a material used in building construction, consisting of a hard, chemically inert particulate substance, known as an aggregate, that is bonded together by using cement and water.

In upcoming years there has been an increase in worldwide demand for the construction of buildings, roads and an airfield which has mitigate the raw material in concrete like aggregate. In some ruler areas, the huge quantities of aggregates that have already been used means that local materials are no longer available, and the deficit has to be made up by importing materials from other places. Therefore, a new direction towards Cellular Lightweight Concrete in building and civil engineering construction is used.

Light weight concrete maintains its large voids and does not form laitance layers or cement films when placed on the wall. This research was based on the performance of aerated lightweight concrete. However, sufficient water cement ratio is vital to produce adequate cohesion between cement and water. Insufficient water can cause lack of cohesion between particles, thus loss in strength of concrete. Likewise, too much water can cause cement to run off aggregate to form laitance layers, subsequently weakening in strength.

Light weight concrete - or foamed concrete - is a versatile material which consists primarily of a cement-based mortar mixed with at least 20% of volume air. It possesses high flow ability, low self-weight, minimal consumption of aggregate, controlled low strength and excellent thermal insulation properties. It can have a range of dry densities, typically from 400 kg/m3 to 1600 kg/m3 and a range of compressive strengths, 1 MPa to 15 MPa.

LITERATURE REVIEW

P.S. Bhandari and Dr. K.M. Tajne: In this research paper they have concluded that the compressive strength for cellular light weight concrete is low for lower density mixture. The

performance of cellular lightweight concrete in terms of density and compressive strength are investigated.

Hjh Kamsiah Mohd. Ismail, Mohamad Shazli Fathi and Norpadzlihatunbte Manaf: In this study paper the main specialties of lightweight concrete are its low density and thermal conductivity. Its advantages, disadvantages and applications were studied thoroughly.

Satyendra Kumar Meena, Pushpendra Kumar Meena, Rakesh Kumar Meena, Rupayan Roy and Pawan Kumar Meena: It was studied that cellular lightweight concrete possesses high flow ability, low self-weight, minimal consumption of aggregate, controlled low strength and excellent thermal insulation properties. It has excellent resistance to water and frost and provides a high level of both sound and thermal insulation.

K. Krishna Bhavani Siram: This paper shows how cellular concrete can be used as a replacement of burnt clay bricks. An attempt is made to compare cellular lightweight concrete (CLC) Blocks and Clay Bricks and recommend a replacement material to red brick in the construction industry.

Cellular Concrete:

Foamed concrete has a surprisingly long history and was first patented in 1923, mainly for use as an insulation material. The first comprehensive review on foamed concrete was presented by Valore in 1954 and a detailed treatment by Rudnai and Short and Kinniburgh in 1963, summarizing the composition, properties, and uses of cellular concrete, irrespective of the method of formation of the cell structure. Significant improvements over the past 20 years in production equipment and better-quality surfactants (foaming agents) have enabled the use of foamed concrete on a larger scale.

Cellular concrete, sometimes referred to as foam concrete, is a lightweight construction material consisting of Portland cement, water, foaming agent and compressed air. The foam is formulated to provide stability and prevent draining of water. Pozzolans such fly ash and fibers are often added to mix to customize compressive and flexural strengths. Cellular concrete typically contains no sand or aggregate.

Cellular lightweight concrete is slurry of cement, sand, water, fly ash and preformed stable foam generated by foam generating machine. By trapping air bubbles within the concrete, a lightweight insulating material is formed. It has fireproofing, insulation, sound attenuation and energy absorbing characteristics. Cellular concrete is either cast-in-place or precast; however, most applications call for a cast-in-place material.

Constituents of Base Mix:

Ordinary Portland cement, Rapid hardening Portland cement and, high alumina and Calcium Sulfo aluminates have been used for reducing the setting time and also to improve the early strength of foam concrete. Fly ash and ground granulated blast furnace slag have been used in the range of 30–70% and 10–50%, respectively and as cement replacement to reduce the cost,

enhance consistence of mix and to reduce heat of hydration while contributing towards long term strength.

Silica fumes up to 10% by mass of cement have been added to intensify the strength of cement. Alternate fine aggregates, viz., fly ash and lime, chalk and crushed concrete, recycled glass, foundry sand and were used to reduce the density of foam concrete.

Making of Cellular Lightweight Concrete:

The components of foam concrete mix should be set by their functional role in order as follows:

a. Foaming agent

b. Binding agent

c. Water

d. Aggregate

e. Admixtures

Properties of Foam Concrete: Fresh state properties: As foam concrete cannot be subjected to compaction or vibration the foam concrete should have flow ability and self-compact ability. These two properties are evaluated in terms of consistency and stability of foam concrete.

Consistency: Flow time using marsh cone and flow cone spread tests are adopted to assess the consistency of foam concrete. The consistency reduces with an increase in volume of foam in the mix, which may be attributed to the (1) reduced self-weight and greater cohesion resulting from higher air content. (2) Adhesion between the bubbles and solid particles in the mix increases the stiffness of the mix.

Stability: The stability of foam concrete is the consistency at which the density ratio is nearly one (the measured fresh density/design density), without any segregation and bleeding.

Physical Properties: Drying shrinkage: Foam concrete possesses high drying shrinkage due to the absence of aggregates, i.e., up to 10 times greater than those observed on normal weight concrete. Autoclaving is reported to reduce the drying shrinkage significantly by 12–50% of that of moist-cured concrete due to a change in mineralogical compositions. The shrinkage of foam concrete reduces with density which is attributed to the lower paste content affecting the shrinkage in low- density mixes.

Low Density and High Strength: Due to its low density, foam concrete imposes little vertical stress on the substructure.

- A particularly important attribute in areas sensitive to settlement. Heavier density ($1000kg/m^{3+}$) foam concrete is mainly used for applications where water ingress would be an issue - infilling cellars, or in the construction of roof slabs for example.

Compressive strength: The compressive strength decreases exponentially with a reduction in density of foam concrete. The parameters affecting the strength of foam concrete are cement–sand and water–cement ratios, curing regime, type and particle size distribution of sand and type of foaming agent used. For dry density of foam concrete between 500 and 1000 kg/m3, the compressive strength decreases with an increase in void diameter. For densities higher than 1000 kg/m3, as the air-voids are far apart to have an influence on the compressive strength, the composition of the paste determines the compressive strength.

Flexural and tensile strengths: Splitting tensile strengths of foam concrete are lower than those of equivalent normal weight and lightweight aggregate concrete with higher values observed for mixes with sand than those with fly ash. The use of Polypropylene fibres has been reported to enhance the performance with respect to tensile and flexural strength of foam concrete.

Functional Characteristics:

Fire Resistance: Foam concrete is extremely fire resistant and well suited to applications where fire is a risk. Tests have shown that in addition to prolonged fire protection, the application of intense heat, such as a high energy flame held close to the surface, does not cause the concrete to spall or explode as is the case with normal dense weight concrete.

Thermal Insulation: Foam concrete has excellent thermal insulating properties due to its cellular microstructure. The thermal conductivity of foam concrete of density 1000 kg/m3 is reported to be one-sixth the value of typical cement– sand mortar.

Advantages of Cellular Lightweight Concrete

Cellular lightweight concrete does not settle, therefore no compaction.

It does not impose large loadings.

It is free flowing so spreads to fill all voids.

It has excellent load spreading characteristics.

Applications of Cellular Lightweight Concrete

Building Blocks: Blocks and panels can be made for partition and load bearing walls. They can be made in almost any dimensions.

Floor Screed: Foamed concrete can be used for floor screeds, creating a flat surface on uneven ground, and raising floor levels.

Roof Insulation: Foamed Concrete is used extensively for roof insulation and for making slopes on flat roofs. It has good thermal insulation properties and because it is lightweight foamed concrete does not impose a large loading on the building. Load Sub-Base: Foamed Concrete is being used on a road subbase on a bridge. Foamed concrete is lightweight so that the loading imposed on the bridge is minimized.

CONCLUSION

It can be concluded that lightweight concrete has a desirable strength to be an alternative construction material for the industrialized building system. This study has shown that the use of fly ash in foamed concrete can greatly improve its properties. The properties of cellular lightweight concrete its advantages, disadvantages and applications were studied thoroughly.

REFERENCES

[1] P.S. Bhandari and Dr. K.M. Tajne,'' Cellular Lightweight Concrete Using Fly Ash'', International Journal of Innovative Research in Science, Engineering and Technology (An ISO 3297: 2007 Certified Organization) Vol. 3, Issue 11, November 2014.

[2] Hjh Kamsiah Mohd. Ismail, Mohamad Shazli Fathi and Norpad zlihatunbte Manaf,''Study of Lightweight Concrete Behaviour''

[3] Satyendra Kumar Meena, Pushpendra Kumar Meena, Rakesh Kumar Meena, Rupayan Roy and Pawan Kumar Meena,''Cellular Lightweight Concrete''

[4] K. Krishna Bhavani Siram ,''Cellular Light-Weight Concrete Blocks as a Replacement of Burnt Clay Bricks'', International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-2, Issue-2, December 2012.

INTEGRATED SOLUTIONS: COMPUTER SCIENCE & ENGINEERING

CHAPTER-6.1

Discovery of Knowledge from Data Mining Techniques

Dr. Vishant Kumar[1], Nitin Kumar[2], Sumika jain[3], Kuldeep Chauhan[4]
[1]Department of Computer Science, JB Institute of Technology, Dehradun, Uttrakhand, India
[2]Department of Computer Science, Shobhit University Gangoh (U.P). India
[3]Department of Computer Science, Shobhit University Gangoh (U.P), India
[4]Department of Computer Science, Shobhit University Gangoh (U.P), India

ABSTRACT—*An evolving topic in today's era is Data Mining and Knowledge Discovery. Data mining and knowledge discovery in databases is attracting a lot of researchers, industry persons, academicians. Why this area is so emerging? This article provides an overview of this emerging field, gives an overview that how data mining and knowledge discovery in databases are related to each other and also to other related fields, such as machine learning, statistics, and databases. The article also mentions real-world applications, specific data-mining techniques, challenges involved in real-world applications of knowledge discovery, and current and future research directions in the field.*

Keywords: Data Mining, Knowledge Discovery, Data Cleaning, Data Warehousing.

INTRODUCTION

Data is raw material of information that can be understood as any facts, numbers, or text which can be processed by machines. Information is the data that has been given some meaning no way of relational connections. For ex data collected from sales transactions can be used to analyze sales trends over the years. Knowledge is application of data and information.it can be considered as general awareness of information, facts, ideas, truth, or principle.

Across a wide variety of fields, data is being collected and accumulated at a dramatic pace. There is an urgent need for a new generation of computational theories and tools to assist humans in extracting useful information (knowledge) from the rapidly growing volumes of digital data. These theories and tools are the subject of the emerging field of knowledge discovery in databases.

At an abstract level, the KDD field is concerned with the development of methods and techniques for making sense of data. The basic problem addressed by the KDD process is one of mapping low-level data (which are typically too voluminous to understand and digest easily) into other forms that might be more compact (for example, a short report), more abstract (for example, a descriptive approximation or model of the process that generated the data), or more useful (for example, a predictive model for estimating the value of future cases). At the core of the process is the application of specific data-mining methods for pattern discovery and extraction.

Data Mining is basically used today by most of the companies with a very strong consumer focus - retail, financial, communication, and marketing organizations, to "drill down" into their transactional data and determine pricing, client preferences and product related

information, impact on the sales, client satisfaction and corporate profits. With the help of data mining, a retailer can use point-of-sale records of client purchases to develop products and promotions to appeal to specific client segments.

Knowledge discovery and data mining have become areas of growing significance because of the recent increasing demand for KDD techniques, including those used in knowledge acquisition, machine learning, databases, statistics, data visualization, and high-performance computing. Knowledge discovery and data mining can be very useful for the field of Artificial Intelligence in many areas, for example education, industry, commerce, government, and so on. The relation between Knowledge and Data Mining, and Knowledge Discovery in Database (KDD) process are presented in the paper. Data mining theory, Data mining tasks, Data Mining technology and Data Mining challenges are also proposed.

The rules of Data mining are around a lot of functional elements. These functional elements also include the following:

Statistics:

This discipline is allocated completely to the analysis of data. Many mathematical models are framed, and the data is used as input for pattern analysis. This is used for association rules verification in data mining process.

Machine Learning:

In this area, the data sets are analyzed for models with statistical inferences and computational parameters. Most of the mining algorithms have machine learning groundwork in them. Database technology: In this phenomenon, the prescribed data set is optimized using different techniques like compression, query compounding and data set indexing and are mined for relevant unknown patterns.

Information Theory:

This discipline is applied in the sector of communication where the information that is synthesized and processed are quantitatively measured by employing a technique where the minimum bits required for encoding is considered. This discipline is used in data mining to get an understandable prioritization of data sets with complex structures.

DATA MINING

Data mining is the process of discovering useful information from large sets of data. Data mining uses mathematical analysis to find out patterns and trends that exist in data. These patterns and trends can be collected and defined as a data mining model. Mining models can be applied to specific scenarios, such as finding Sequences, forecasting, grouping.

The area of data, data mining tasks, and data mining approaches faces many challenging research matters in data mining. The development of efficient and effective data mining methods and systems, the construction of interactive and integrated data mining environments, the design of data mining languages, and the application of data mining

techniques to solve large application problems are important jobs for data mining researchers and data mining system and application developers. Several well-established statistical methods have been introduced for data analysis, such as regression, generalized linear models, analysis of variance, mixed-effect models, factor analysis, discriminant analysis, time-series analysis, survival analysis, and quality control. Researchers have been attempting to build theoretical foundations for data mining. Several interesting proposals have appeared, based on data reduction, data compression, pattern discovery, probability theory, microeconomic theory, and inductive databases. There are many data mining systems and research prototypes to choose from. When selecting a data mining product that is appropriate for one's task, it is important to consider various features of data mining systems from a multidimensional point of view. These include data types, system issues, data sources, data mining functions and methodologies, the tight coupling of the data mining system with a database or data warehouse system, scalability, visualization tools, and data mining query language and graphical user interfaces. Many customized data mining tools have been developed for domain-specific applications, including finance, the retail industry, telecommunications, bioinformatics, intrusion detection, and other science, engineering, and government data analysis. Such a Scheme integrates domain-specific knowledge with data analysis methods and provides mission-specific data mining solutions. The Proposed research work acts as a root for new works and assessment proof of the current work.

PRINCIPLES OF KNOWLEDGE DISCOVERY

Knowledge discovery is the phenomenon of finding previously unknown patterns and designs from a big volume of data sets and converting the obtained patterns into understandable and applicable knowledge information. This domain of Knowledge discovery consists of many processes. These processes can take place at various stages, which form the basic rules of Knowledge Discovery domain. These processes are Data Orientation: gather all the required data and build up one single accessible repository.

Data cleansing:

Data is processed, analyzed, and processed for better procedural treatment.

Data Selection:

Selecting the required data from the given data sets for obtaining pattern.

Pattern Identification:

The data sets are treated to unknown patterns and designs.

KNOWLEDGE DISCOVERY PROCESS

Knowledge discovery is the process of finding knowledge in the given datasets irrespective of their characteristics and size attributes. The process of understanding and extracting the pattern from the given databases comprises of many steps. It is clearly illustrated in the following figure 1.

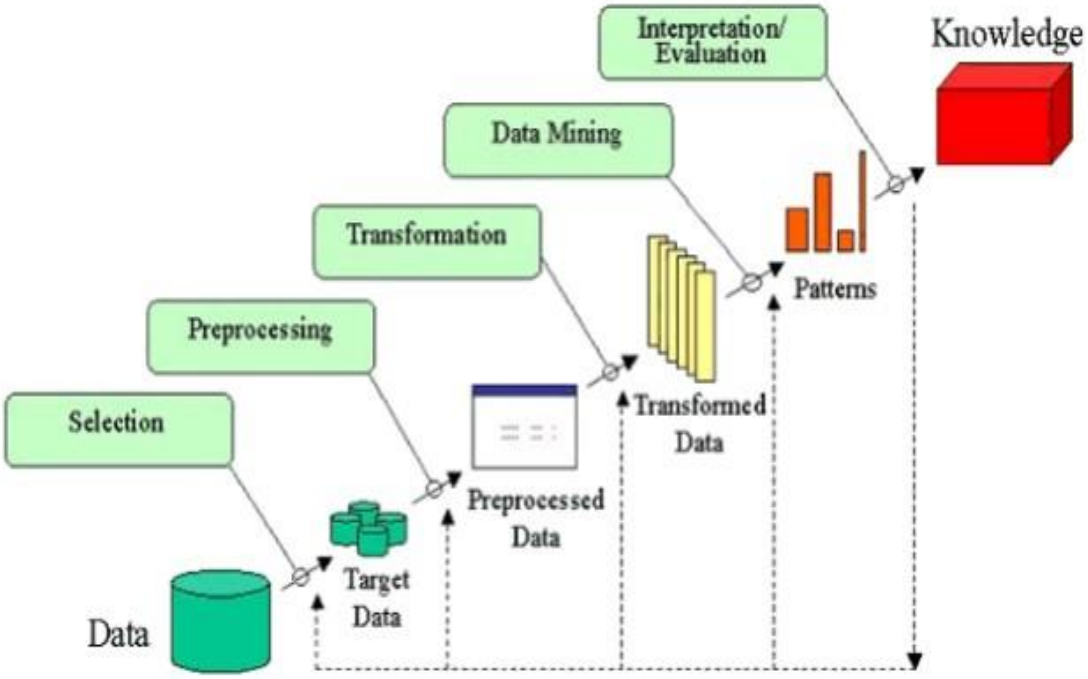


Figure.1. Knowledge Discovery Process

When a database is selected for data analysis, five main aspects should be considered. They are the factors to which the database belongs, Knowledge Prerequisite that is needed to understand the database, Application Knowledge required to obtain the required characteristics, Objective that has to be fulfilled after data pattern extraction and the level of attainment that is achieved after the pattern is discovered from the database. For the data pattern extraction process to be successful, we have to select the concerned dataset and create the desired variables that are required for correct or matching and analysis of the database. If the concerned variable is not properly done into the database, then it will result in biased data pattern output. After the concerned variable is fixed, the data-set is cleansed and is made to go into the pre-processing process. In the data cleansing stage, the data is removed from all the noises, incompleteness. These data-noises should be counted by collecting needed information for future enhancement of the removal process. Once the noises are removed after proper accounting made for them, data is reduced and are projected based on the objective that has to be fulfilled after data pattern extraction and the level of attainment that is gain after the pattern is discovered from the database. Once the data projection is made, the method of extraction of the data should be selected. The method that is to be employed for data extraction has to be carefully chosen because the method that is employed determines the level of uniqueness in the data extraction process.

FUTURE WORK

Data mining is defined as the phenomenon of discovering patterns from huge amount of data. The process should be automatic or (more usually) semi-automatic. The patterns discovered should be relevant in that they lead to some advantage, mostly an economic one. The data is invariably present in substantial quantities. And how are the patterns expressed? Relevant

patterns allow us to make nontrivial predictions on new data. There are two extremes for the expression of a pattern: as a black box whose innards are effectively incomprehensible, and as a transparent box whose construction reveals the structure of the pattern. Both are making good predictions assumptions. The difference is whether the patterns that are mined are represented in terms of a structure that can be examined, reasoned about, and used to inform future decisions. Such patterns are structural because they capture the decision structure in an explicit way. In other words, they help to elaborate something about the data. The proposed framework, by itself, has versatile groundwork both literature wise and procedural wise. This framework was formulated by studying a lot of domain related literature works presented in various conferences and journals. The proposed framework can be applied to various research studies. This framework can be used to make the students in the domain of Data Mining and Knowledge Discovery. The future work will include the more detailed study of the related areas with a clear definition based on new analytical techniques that must be employed when it comes to analyzing data from interdisciplinary areas.

REFERENCES

[1] Pushpal Desai, Knowledge Discovery from Vehicle E-Governance Data Using Data Warehousing and Data Mining. International Journal of Information Technology & Management Information System (IJITMIS), 5 (2), 2014, pp. 40–50.

[2] Hill, S., Benton, A., Ungar, L., Macskassy, S., Chung, A. and Holmes, J.H., 2016. A Cluster-based Method for Isolating Influence on Twitter.

[3] Lorenzetti, C., Maguitman, A., Leake, D., Menczer, F. and Reichherzer, T., 2016. Mining for Topics to Suggest Knowledge Model Extensions. ACM Transactions on Knowledge Discovery from Data (TKDD), 11(2), p.23.

[4] Al-Hamidi, A., Lu, S. and Al-Salhi, Y., 2016. An enhanced frequent pattern growth based on MapReduce for mining association rules. International Journal of Data Mining & Knowledge Management Process (IJDKP) 2016, 6(2), pp.19-28

[5] Tayal, K. and Ravi, V., 2016, August. Particle Swarm Optimization Trained Class Association Rule Mining: Application to Phishing Detection. In Proceedings of the International Conference on Informatics and Analytics (p. 13). ACM.

[6] T. Venkatesan, T. Ramkumar and K. Saravanan, 2017, Mining Big Data: Towards a Machine Learning Framework Based on Collaborative Filtering. International Journal of Control Theory and Applications.

[7] Narang, S.K., Kumar, S. and Verma, V., 2017. Knowledge Discovery From Massive Data Streams. In Web Semantics for Textual and Visual Information Retrieval (pp. 109-143). IGI Global.

[8] Mathews, D., 2016. Data Mining and Machine Learning Algorithms for Workers' Compensation Early Severity Prediction (Doctoral dissertation, Middle Tennessee State University).

[9] Dasgupta, H., 2017. Data Mining and Statistics. Handbook of Research on Advanced Data Mining Techniques and Applications for Business Intelligence, p.15.

[10] Ramasubramanian, P., K. Iyakutti, and P. Thangavelu. "Enhanced data mining analysis in a higher educational system using rough set theory."African Journal of Mathematics and Computer Science Research 2, no. 9 (2009): 184-188.

[11] Ben-David, A., 2016. What does the Web remember of its deleted past? An archival reconstruction of the former Yugoslav top-level domain. new media & society, p.1461444816643790.

[12] Amani, F.A. and Fadlallah, A.M., 2017. Data mining applications in accounting: A review of the literature and organizing framework. International Journal of Accounting Information Systems, 24, pp.32-58

[13] Thakuriah, P.V., Tilahun, N.Y. and Zellner, M., 2017. Big data and urban informatics: innovations and challenges to urban planning and knowledge discovery. In Seeing Cities Through Big Data (pp. 11-45). Springer International Publishing.

[14] Wilson, S.J., 2017. Data representation for time series data mining: time domain approaches. Wiley Interdisciplinary Reviews: Computational Statistics, 9(1).

CHAPTER-6.2

Attitude Estimation Using Mems Based Sensors

Wajahat Gh Mohd[1], Dr. Vishant Kumar[2], Dr. Bharat VPS Rawat[3]
[1]Assistant. Professor, Deptt. of CSE JB Institute of Technology, Dehradun, Uttrakhand
[2]Professor, JB Institute of Technology, Dehradun, Uttrakhand
[3]Associate Professor, JB Institute of Technology, Dehradun, Uttrakhand

ABSTRACT: *Position estimation systems often use two or more different sensors to increase reliability and accuracy. Gyroscopes do not have the problems of limited range, interference, and field of view obscuration, but they suffer from slow drift. On the other hand, accelerometers are drift-free but have slow dynamics. This work investigates the use of a complementary filter to provide real-time estimates of the location and position of an underwater vehicle. The filter is designed to account for a number of real-life complications. These include different sensor output speeds, long gaps in receiving position information.*

INTRODUCTION

Inertial measurement technology is available to commercial users today thanks to a significant reduction in price over the past decades. Consequently, low-cost inertial sensors can be integrated with a satellite navigation system using a conventional Kalman filter or a nonlinear state observer.

The Key Components of the IMU are:

Gyroscopes: The classic gyro is a spinning wheel that utilizes conservation of momentum to detect rotation and belongs naturally in a gimballed system. For strap down applications, optical gyros such as ring laser gyros (RLG) and fiber optic gyros (FOG) have been used for some time and are also expected to be the standard for high accuracy strapdown inertial systems for the foreseeable future.

For low and medium cost applications, gyros based on micro-electric-mechanical systems (MEMSs) are expected to be dominant.

Accelerometers: There are several different types of accelerometers. Two of these are mechanical and vibratory accelerometers. The mechanical accelerometer can be a pendulum, which in its simplest form is based on.

STUDY OF MEMS SENSORS

A Gyroscope is a gadget used to gauge rakish speed. It has wide application in the field of route. A rate gyro is a sort of spinner, which shows the heading just as the pace of progress of edge with time.A gyro with one single gimbal ring and two planes of freedom can be adapted for use as a rate gyro to measure a rate of angular moment. The rate gyro is an open loop system. Whereas the rate indicating gyro is a closed loop version of the rate gyro. FOG are solid-state rotation sensors that are appropriate for a wide variety of applications. FOGs bring

with it the advantages of long life, high reliability, input axis stability, and low acceleration sensitivity.

High performance, long-lifetime gyroscope applications, such as satellite pointing, was formerly the domain of spinning wheel gyroscopes. Recently, the fiber optic gyroscope (FOG) has reached performance levels that make this solid-state rotation sensor appropriate for application like these. As with ring laser gyroscopes (RLGs), FOG exhibits a high reliability and excellent input axis (IA) stability due to their solid-state nature. Advantages of the FOG are the lack of a high-voltage power supply requirement, the elimination of mechanical dither and its associated reaction torques, and the ability to obtain small angle quantization more easily.

AlliedSignal has designed a "pointing grade" fiber optic gyroscope (PG FOG) that is suitable for long-life, high accuracy missions. The basic FOG mechanization is like that of AlliedSignal's other grades of FOG. Higher accuracy is achieved in the PG FOG through the use of a 3000-meter fiber length and 14 cm coil winding diameter. FOG is very expensive and used in applications with high accuracy.

Advantage of FOG Technology

1. No moving parts

2. High stability over time

3. High stability over temperature

4. Reliability, Long MTBF

5. Low sensitivity to environmental factors

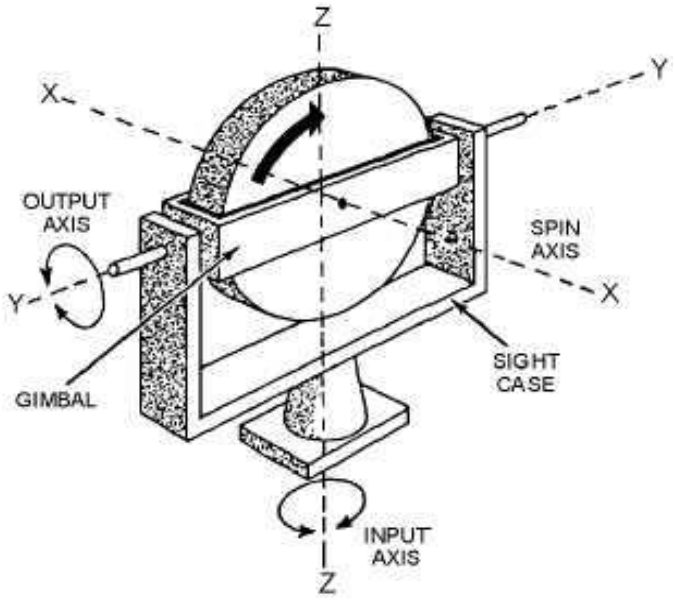


Fig. 1. Rate Gyro

Another sort of rate gyro is the Floated Gyro unit. This unit for the most part exercises self-control and is known as a torsion bar. The upside of the torsion bar. The upside of the torsion bar over the spring is that the torsion bar needs no switch arm to apply torque. The torsion bar is mounted along the yield pivot (fig.) and produces controlling torque in either heading by curving as opposed to pulling. Additionally, there is no gimbal bearing contact to cause impedance with gyro activity.

A liquid encompasses the gyro circle and gives buoyancy. It likewise gives security from stun and damps the motions coming about because of abrupt changes in the precise rate input. In this gyro, the inward gimbal dislodging must be estimated with some sort of electrical pickoff. As the gyro case is pivoted about the information hub, clockwise or counterclockwise, a precession torque will be created about the yield hub that will make the inward gimbal apply torque against the torsion bars.

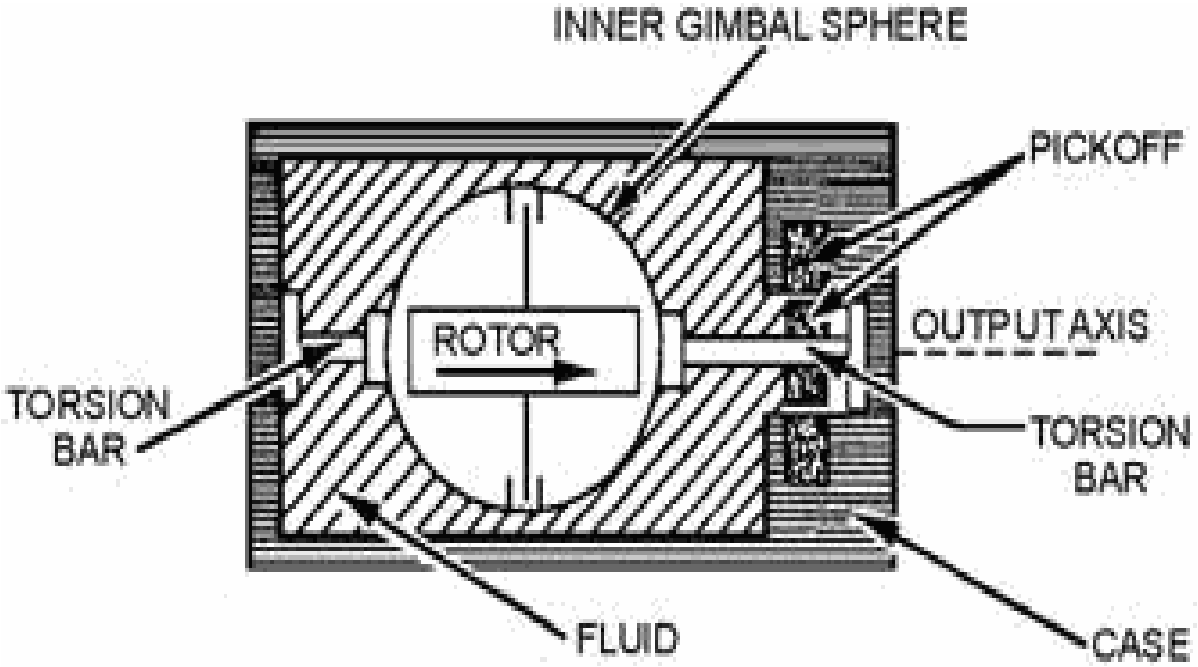


Fig.2. Floated Rate Gyro

Principle of MEMS Based Accelerometer [4]

Current accelerometers are regularly little electromechanical framework (MEMS), comprising of minimal in excess of a cantilever pillar with a proof-mass acknowledged in single precious stone silicon utilizing surface micromachining or mass micromachining forms.

There are a wide range of approaches to make an accelerometer. A few accelerometers utilize the Piezo-electric impact. They contain minuscule gem structures that are worried by accelerative powers, which makes a voltage be produced. Another approach to do it is by detecting changes in capacitance. MEMS accelerometers are one of the simplest but also most applicable micro-electromechanical systems. They became indispensable in automobile industry, computer, and audio-video technology.

A typical MEMS accelerometer is composed of movable proof mass with plates that are attached through a mechanical suspension system to a reference frame. Movable plates and fixed outer plates represent capacitors. The deflection of proof mass is measured using capacitance.

Low and High Pass Filters: Linear Time- Varying Setting

The concepts of low pass and high pass filters play an important role in assessing the performance of complementary filters and are well understood in the case of LTI systems. We are now extending these concepts to the class of linear time-varying systems. The new concepts play a major role in assessing the performance of the linear time-varying complementary filters that are introduced later.

High Pass Filter with Break Frequency ωc

A linear, internally stable time-varying system G is said to be an (ϵ, n) low pass filter with break frequency ωc if (1-G) is an (ϵ, n) low pass filter with bandwidth ωc.

The conditioning of the definition of low pass filters generalizes the following facts that are obvious in the LTI case.

1. The filter must provide a gain equal to one at zero frequency.

2. There is a finite band of frequencies over which the system behavior replicates very closely that of an identity operator.

3. The system gain rolls-off to zero at high frequency.

The order of the filter can be made sufficiently large to make it effectively select the “low frequency components” of the input signal.

Time-Varying Complementary Filters: Navigation Problem Formulation

The basic concept of complementary filtering to the time-varying setting. The motivation for this work can be simply described by considering the example where one is interested in estimating the position p and v of a vehicle based on measurements pm and vm of p and v, respectively.

In the case of an ocean surface vehicle, pm is provided by a Differential Global Positioning System (DGPS), whereas vm is provided by a Doppler sonar. In the case of a fully submerged underwater vehicle, pm can be provided by a Long Baseline System.

Due to the physical characteristic of the Doppler sonar the measurement vm is naturally expressed in body-axis, that is. In the reference frame{B}. Furthermore, Doppler bias effects are naturally expressed in {B}.

This is in contrast with the measurements pm, which are directly available in the reference frame {I}. These facts impose important constraints on the class of complementary filters for position and velocity estimation.

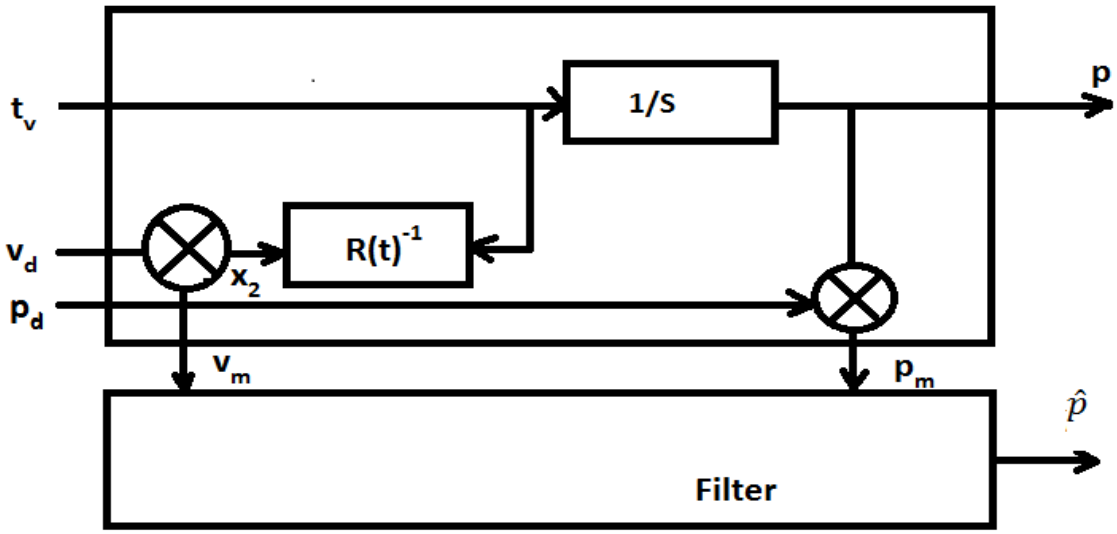


Fig. 3. Underlying Process Model

Where vd,0 is the Doppler bias. This set-up is all that is required for the design of complementary filters from a frequency-like domain point of view. Notice that the process model Mpv is time-varying due to the presence of the rotation matrix R(t). However, the entries of R(t) and their derivatives are not arbitrary functions of time, but exhibit bounds that depend on each specific vehicle mission under consideration. For example, if an underwater vehicle motion is restricted to the horizontal plane and the maximum yaw rate achievable with that vehicle is rmax, then this information must be explicitly included in the description of the process model Mpv.

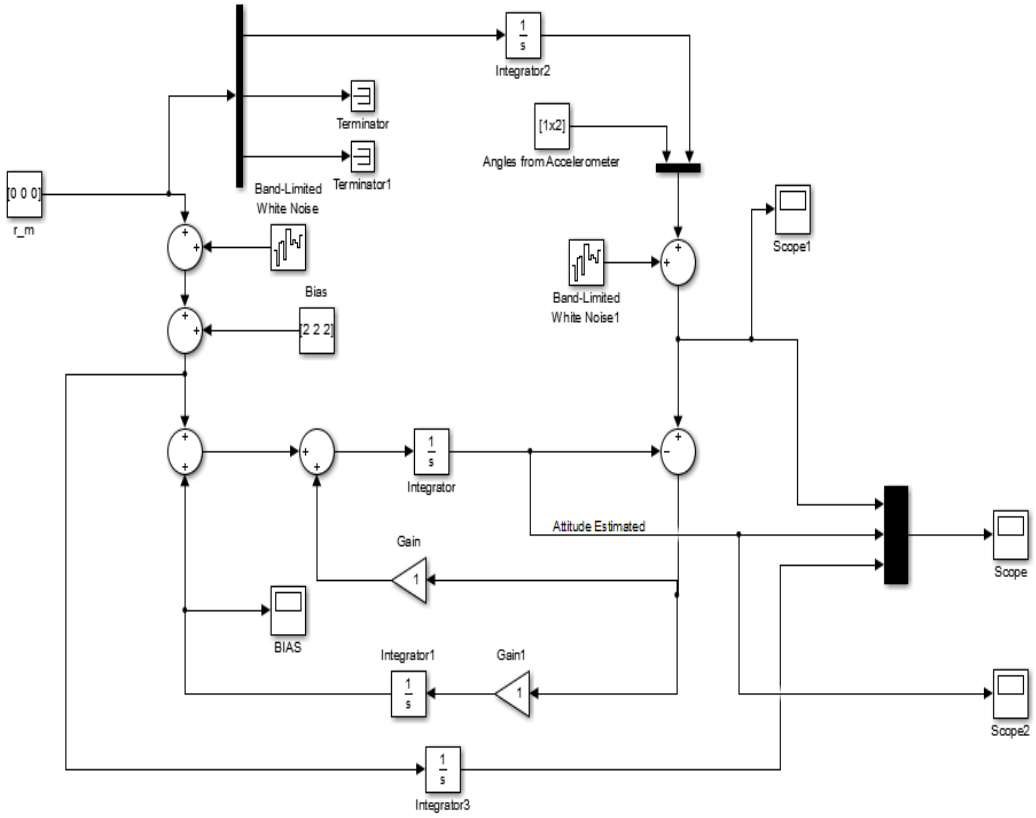


Fig.4 103-axis Complementary Filter

CONCLUSION

Above we showed a mathematical model that are required to design a complementary filter. However, the outcome of the design process may very well be a filter with an effective bandwidth that is greater than one required. Although the situation and modelling of initial complementary filter is identical to Kalman filters.

It is shown that the gyroscope and accelerometer noise pertaining to analog devices MEMS inertial Measurement Sensor have similar second order models which may be determined with sufficient accuracy by using the frequency-domain and time-domain characteristics of the noises. The error models are implemented as programs in MATLAB are appropriate for usage in the development of filters for navigation and control systems [1].

REFRENCES

[1] T. S. Petko petkov, "stochastic modeling of mems inertial sensors," in cybernetics and information technologies • volume 10, no 2, 2010.
[2] Gyroscopes.org, gyroscopes.org, http://www.gyroscopes.org/uses.a.
[3] R. A. A. M. Besley, "acceleration and deceleration models," in monash university, melbourne, australia,23rd conference of australian institutes of transport research (caitr 2001), australia, 10-12 december 2001.
[4] M. Andrejasic, mems accelerometer, http://mafija.fmf.uni-lj.si/seminar/files/2007_2008/mems_accelerometers-koncna.pdf.
[5] Xyz, "market watch," [online]. Available: http://www.marketwatch.com/story/global-mems-gyroscope-market-2012-2016-2013-12-26.
[6] C. H. Robitics, fundamental of attitude estimation, http://www.chrobotics.com/library/attitude-estimation.
[7] R. Yadlin, "attitude determination and bias estimation using kalman filtering," in united states air force academy, colorado springs, colorado, 80841.
[8] R. G. Brown, "introduction to random signal analysis and kalman filtering," in new york: john wiley & sons, 1983.
[9] G. A. G. B. Welch, " an introduction to the kalman filter," in chapel hill: university of north carolina at chapel hill, 2006.

CHAPTER-6.3

Importance of Machine Learning in Clinical Trial and Research

Atul Bhandari[1], Dr. Vishant Kumar[2]
[1]Assistant Professor, JB Institute of Technology, Dehradun
[2]Professor, Department of Computer Science, JB Institute of Technology, Dehradun, Uttrakhand, India

ABSTRACT: *Clinical trials are human research projects that assess the effectiveness of a medical, surgical, or behavioral intervention. They are the primary method used by researchers to assess whether a novel therapy, such as a new drug, diet, or kind of care, is medically advantageous in people. Clinical research has several difficulties since it is expensive, has a poor success rate, and frequently fails to choose the correct persons for trials when there is inadequate technological infrastructure. Therefore, machine learning can be quite important in this area.*

Keywords- Clinical Trials, Clinical Research, machine learning

INTRODUCTON

An essential part of the pharmaceutical development process is conducting clinical trials. They are the research studies performed to determine if a treatment method or product is effective and safe when utilized on people. Despite its ups and downs, the pharmaceutical sector is still quite profitable. Global legal medication spending is anticipated to increase at a pace of 2% annually, according to Quintiles IMS Holding. Clinical trials are difficult for researchers to perform since they are expensive and have a low likelihood of success. According to the US FDA, just one out of every ten medications used on people is approved, and the testing process is extremely expensive [1].

CLASSIFICATION OF CLINICAL RESEARCH

Therapeutic studies: They evaluate the efficacy of a treatment in curing a medical state. If one does, it is often contrasted with an already-in-use alternative treatment to see which is more effective. The size of these studies varies depending on the number of participants and the type of study [6].

Mechanistic experiments derived from the word "mechanism": In this research, it is sought to ascertain if a treatment's impact on biochemical processes in the body is a therapeutic effect or a side effect [6].

CHALLENGES WITH CLINICAL RESEARCH (without the use of Machine Learning):

Low success rates and high expenses:

To bring a single new drug to market, clinical trials take up the second part of a 10- to 15-year development period and cost between $1.5 billion and $2.0 billion. Therefore, a failed drug study results in a loss of between 800 million and 1.4 billion dollars for each unsuccessful clinical trial [6], not only for the trial itself but also for the preclinical

manufacturing expenses.

Selection of the patient cohort:

The goal of clinical trials is frequently not to demonstrate a drug's effectiveness in a representative sample of the general population, but rather to prospectively select a subset of the population where the drug's effect, if any, will be easier to demonstrate. This method is referred to as "clinical trial enrichment." The observed efficacy of the medicine would be automatically decreased if a patient were included in the trial who was not already a member of the proper subgroup. Suitability refers to a disease that may not make it difficult or incredibly rare for participants to react to the medicine being evaluated. Suitability should not be confused with the degree of treatment efficacy or lack thereof throughout the study. Enrolling unfit patients increases the trial's likelihood of failing, even while having a high number of eligible participants does not guarantee an experiment's success [7].

Recruiting techniques:

Due to the uncertainty of the trial eligibility standards in terms of number and medical language, patients find it challenging to grasp and assess their own eligibility. It is a tremendous difficulty for both physicians and patients to manually get useful data from this enormous and unstructured data set. However, this stage primarily determines whether a patient is deemed acceptable and competent to register in a study, as well as if the recruiting site and the patient are aware of one another [7].

Poor technological infrastructure:

The current clinical trials infrastructure is thought to be insufficient to meet the demands of a transformed Clinical Trials Enterprise (CTE) that would promote the speedy discovery of novel and effective therapies, produce accurate and trustworthy information regarding the clinical efficacy of health care treatments, and support a learning health system. Currently, the infrastructure for clinical trials is being built through trials or sponsorship, leading to "one-off" experiments that draw significant funding but are ultimately dismantled. Many have suggested that efforts to create a long-lasting, reliable clinical trials infrastructure might enhance the CTE's overall effectiveness and performance [7].

Role of Machine Learning in Clinical Trial and Research:

1. The creation of a pool of applicants from a variety of data sources, such as past medical visits, social media, and so on, may be facilitated by researchers using machine learning-based predictive analytics to identify potential clinical trial participants [8].

2. By utilizing the capabilities of electronic records, machine learning is currently being utilised to assure real-time tracking and data access for research volunteers, choose the proper sample size to analyse, and minimize data-based mistakes [9].

AREAS OF CLINICAL TRIALS WHERE MACHINE LEARNING IS CRUCIAL

Study design: Because AI and machine learning can help with the estimation of the ideal

dose and configuration required for a drug to pass clinical trial stages, they can be incorporated into protocol design, allowing manufacturing companies to save money while delivering high-quality medications or therapy to patients more quickly [10].

Monitoring by Clinical Research Organization (CRO):

In the past, the CRO team oversaw the overseeing of clinical science's 100% source data authentication. Because clinical supervision is an expensive and time-consuming process, the most current ICH-GCP guidelines have chosen a lean approach to this process. This calls for threat-based monitoring, or risk-based monitoring (RBM).

- The integration of data from many applications, as well as the precise analysis and tracking of issues and dangers that people may otherwise miss, can be facilitated by data science tools and methodologies [10].

Site selection with the required population pool:

Finding a location with the demographic pool required by the protocol is one of the most significant issues the CRO encounters. This may be avoided by employing efficient recruitment strategies in addition to applying AI and machine learning tools to identify and suggest places with the best recruiting chances.

- To do this, it is necessary to evaluate patient demographics and proactively pinpoint locations with the best potential for accommodating many patients [11].

Identifying and recruitment of patients:

Patient identification and recruiting are two of the most significant issues that most CROs face, and these issues contribute to variations from the study's initial recommendations. This is because of the sample's monitoring and recruitment of the patient population. Due to issues with their health or other events, the patient can already be eliminated from the analysis before it is finished.

- By minimizing demographic heterogeneity throughout the enrollment process, AI has the potential to lower this dropout rate. A patient's ability to accomplish the study endpoints will be determined by data science software based on their medical history and protocol requirements. [12]

Pharmacovigilance:

To make sure that opioid protection is achieved, a sizable amount of organised and unstructured data must be analysed.AI and machine learning systems will therefore be able to address many of the problems and provide fresh viewpoints on medication safety. [13]

CONCLUSION

The future of clinical development is on the cusp of a significant change as a result of the convergence of enormous new digital data streams, computational resources to find clinically relevant trends in the data using effective artificial intelligence and machine-learning

algorithms, and regulators welcoming this revolution through new partnerships. This viewpoint summarizes viewpoints, recent developments, and recommendations for incorporating pertinent computational data into clinical research and health care from the academic community, the biotechnology community, non-profit foundations, legislators, and technological businesses [15].

REFERENCES

[1] Kumba, "Ai and machine learning for clinical trials – examining 3 current applications," March 2019.
[2] A. Cristina and M. Castelo-Branco, "Preparation of an academic clinical trial," pp. 317–330, 2021.
[3] L. G. Portney, Foundations of clinical research: applications to evidence-based practice. FA Davis, 2020.
[4] K. T. Hall, L. Vase, D. K. Tobias, H. T. Dashti, J. Vollert, T. J. Kaptchuk, and N. R. Cook, "Historical controls in randomized clinical trials: Opportunities and challenges," Clinical Pharmacology Therapeutics, vol. 109, no. 2, pp. 343–351, 2021.
[5] J. Poythress, M. Y. Lee, and J. Young, "Planning and analyzing clinical trials with competing risks: recommendations for choosing appropriate statistical methodology," Pharmaceutical statistics, vol. 19, no. 1, pp. 4–21, 2020.
[6] P. Nadkarni, Clinical Research Computing: A Practitioner's Handbook. Academic Press, 2016.
[7] W. R. Zame, I. Bica, C. Shen, A. Curth, H.-S. Lee, S. Bailey, J. Weatherall, D. Wright, F. Bretz, and M. van der Schaar, "Machine learning for clinical trials in the era of covid-19," Statistics in Biopharmaceutical Research, vol. 12, no. 4, pp. 506–517, 2020.
[8] X. Lin, X. Li, and X. Lin, "A review on applications of computational methods in drug screening and design," Molecules, vol. 25, no. 6, p. 1375, 2020.
[9] M. Jacobs, M. F. Pradier, T. H. McCoy, R. H. Perlis, F. Doshi-Velez, and K. Z. Gajos, "How machine-learning recommendations influence clinician treatment selections: the example of the antidepressant selection," Translational psychiatry, vol. 11, no. 1, pp. 1–9, 2021.
[10] M. Hauben and C. G. Hartford, "Artificial intelligence in pharmacovigilance: Scoping points to consider," Clinical Therapeutics, 2021.

CHAPTER-6.4

Study of Facial Emotion Recognition and Eye-Tracking for the Development of Communication Framework

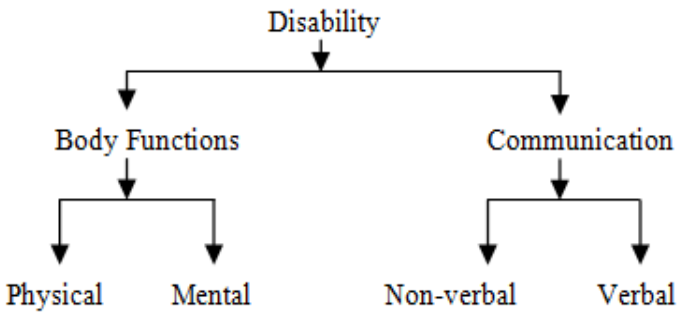
Pradeep Kumar Kaushik, Shivam Pandey, Sushil Singh Rauthan
Department of CSE, JB Institute of technology, Dehradun
pradeep.kaushik87@gmail.com

Abstract – *This paper introduces a study of the implementation of facial emotion recognition and eye tracking technology for mentally fit intensive speech, disabled persons. It also presents a study of the augmentative and alternative communication, at present developed emotion recognition frameworks and few current speech disability support devices chosen from the internet. Using these techniques, the proposed design of simplex real-time communication framework to facilitate efficacious analysis of sentiments of speech-disabled person is recommended in this paper. Although several devices are present, few with eye-tracking feature, but there is still a requirement for more versatile, cost-efficacious device and the challenge is to achieve speech like a human from augmentative and alternative communication enabled device.*

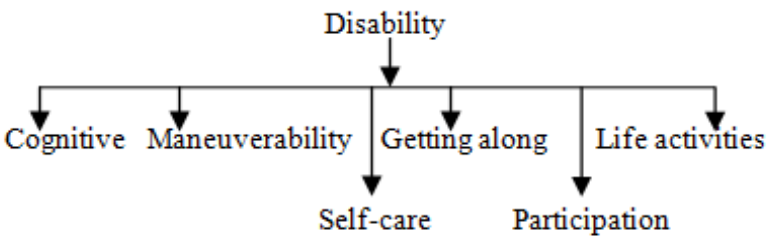
Keywords- Eye-tracking technology, Facial Emotion Recognition, Augmentative and alternative communication

INTRODUCTION

Disability is a fixed term, containing impairments, action limits, and participation limitations. Impairment is a problem in body action or structure; an action limitation is trouble confronted by a person in performing a task; while a participation limitation is a problem faced by a person in involvement in life situations [1][41]. Disability can be categorized into different categories.



[Fig-1.1 A]



[Fig-1.1 A, B -Types of disability][2]

Physical disability is a limitation on a person's physical action or motion. While speech disability is a communication disorder such as voice impairment, language impairment, impaired articulation, and stuttering. Both negatively affect an individual's educational, social and professional performance. More than 1000 million people in the world have few type of disability. Disabled persons are more possibly to be jobless.

The employment rate for disabled persons (44%) is slightly over half that for general persons (75%) in the group of Economic Cooperation and Development countries [3]. There is more exploration range in speech disability than physical disability. Surbhi Rathi et al. [4] highlight the problem of communication faced by deaf and dumb, the communication system is chosen for exploration.

It has been seen since the '90s that exploration with respect to speech and other disabilities is going on; augmentative and alternative communication is the best resolution for speech disability. Pat Mirenda et al. [5] analyzed the issues referred to the communication of augmentation for persons with intensive mental disabilities. Barry M. Prizant et al. [6] introduced a huge expansion of speech, language and communication disorders in kids related to psychiatric and brain health for sentimental and behavioral issues.

The acquired knowledge can be used in the development of support devices for communication. Also, emotion recognition has been an important input for efficacious human-computer interaction. Emotion can be defined as an attentive experience characterized by fast brain action and a definite intensity of pleasure or displeasure [7]. Emotion can be recognized through facial expressions, voice, and physiological signals. But facial expressions are the rich source of emotions.

FACIAL EMOTION RECOGNITION

Facial emotion recognition is the procedure of recognizing human emotion, from facial expressions [7]. Facial emotion recognition is the emerging application region of human-computer interaction and computer vision. Modern years have witnessed an increasing attraction in systems able to interpreting facial emotions and responding to them. These systems can be used for designing human-computer interfaces, online contents, videos, advertisements, and games. Salwa Said et al. [8] proposed the latest technique for facial expression recognition based on wavelet network classifier; it permits the trace of 6 key emotions: sadness, anger, fear, hatred, joy, and surprise.

This paper discussed the possible application in the detection of driver emotional state, smart television by facial controls. Emotion recognition has also application in the intelligent communication systems, intelligent wheelchair, navigation path system, etc. for physically, visually and other disability support frameworks. Emotion recognition is important for a speech generating device so that the output speech contains the user's emotions. Priya Saha et al. [9] introduced a paper to trace the region of interest (ROI) of expressive facial images. Face recognition and facial emotion recognition are active exploration areas, an ROI (triangular area covers from left eye to right eye and lips on the face) plays a crucial role in

them because major facial expressions always expressed by the muscles of this area. Normally emotions are specified into seven: anger, disgust, fear, joy, sad, startled and neutral. Jyoti Kumari et al. [10] introduced a survey paper, the paper analyses the different facial emotion recognition techniques normally based on geometry and appearance. Ma Xiaoxi et al. [11] introduced a paper and compared the experiment outcomes of various prediction frameworks and concluded that the excellent performance of occurrence detection of AUs is got by sentimental facial classification framework with SVM. Hence, emotion recognition has huge importance in a speech generating device or in the area of augmentative and alternative communication.

THE RELATION BETWEEN FACIAL EMOTION AND SPEECH PRODUCTION

Speech is the biometric property of a human, emotion can be recognized from speech. Mohan Ghai et al. [12] introduced a paper and main aim is to identify sentiments in speech and categorize them in 7 sentiment classes - neutral, sadness, boredom, hatred, anxiety, happiness, and anger. The introduced viewpoint is based upon the Mel Frequency Cepstral Coefficients (MFCC) and energy of the speech signals as feature inputs and uses Berlin database.

The paper concluded that the insertion of energy as a feature containing other thirteen MFCC features lead to the good evaluation of the emotion present in the speech. But we analyze that 13 MFCC features extracted from human voice samples can be inserted in synthetic speech after recognition of facial emotion of the speech-disabled user. Hence the reverse process can generate synthetic expressive speech because the absence of expressivity is the major problem in the present speech generating devices or disability support frameworks.

PROBLEM WITH FACIAL EMOTION RECOGNITION

Roshan Jameel et al. [13] introduced a survey paper that analyzed the few issues in the area of facial expression recognition and has discussed a few techniques used to the aim of facial expression recognition. The problem being faced currently in facial expression recognition is the absence of databases having the natural facial expression and preparing a similar database is the big challenge.

For this, the approach of using secret cameras will not act efficaciously. Search out the labeling data for investigation, this practice is a challenge too; creating a fully genuine database is very hard but the semi-genuine database is relatively easy. So, this paper focuses on creating a database and sets out few of the important problems during the creation of a database.

CLASSIFICATION PERFORMANCE OF FACIAL EMOTION RECOGNITION

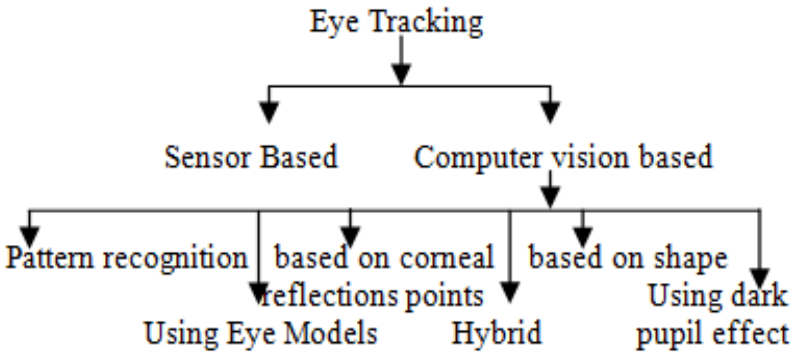
Various classifiers (Table 2.1) can be used to classify the captured emotion.

[**Table 2.1**:-classification performance of popular classifiers, employed for the task of facial emotion recognition]

Classifier	Average Classification Accuracy	Reference
Patch-based Gabor	92.93-94.48%	[14]
KNN	94.8-97.63%	[15]
MLP	90%	[16]
3-NN	96%	[16]
ICA and HMM	81.67%	[17]
LDP and HMM	82.08%	[17]
LD^2 BP and HMM	84.17%	[17]

EYE TRACKING TECHNOLOGY

Eye tracking technology measures the pupil movement of the eye relative to the head. Eye tracking is the easiest human-computer interface. It has application in the easy pilot interface, disability support framework, assistive technology, E-learning, Car assistive systems, Iris recognition and Field of view estimation. A disabled user can easily operate it by eye motion. Eye tracking technology has been used in commercial products: Eagle eyes, Blink, Smi, Tobii.



[**Fig: 3.1**-Types of Eye-tracking techniques]

Pramodini A. Pune et al. [18] introduced a study of eye tracking technology its type and application. Amer Al-Rahayfeh et al. [19] introduced a review paper on eye tracking and head movement detection; this is an active exploration field in human-computer interaction.

AUGMENTATIVE AND ALTERNATIVE COMMUNICATION (AAC)

AAC is the communication manner used for replacement of speech or writing for those with impairments in the composition of spoken or written language. AAC is the best resolution

for speech disability. So many devices are available to facilitate the AAC, but many of them are not expressive (output speech is synthetic). Shaun K. Kane et al. [20] introduced a paper and conducted interviews with 7 individuals with Amyotrophic Lateral Sclerosis and their fellows, concentrating on how AAC use affected their communication and personal expression. Alexander Fiannaca et al.[21] discussed a method voice setting for improved expressivity in AAC. Basically, conveying emotions in speech is expressivity, in this paper expressive keyboard and voice setting editor is used for fast insertion of expressivity in speech. Expressive Keyboard allows the insertion of emoji and punctuation into text for fast expressivity in speech.

RELATED WORKS

Augmentative and alternative communication is the active exploration field, few of the already developed devices or frameworks are chosen as related works.

Christos D. Katsis et al. [22] introduced a unified framework based on physiological signals; the paper described a methodology, named Intrepid system which provides a resolution for the observation of patients with worry disorders during therapy. The limitation of the Intrepid system is that it can capture only five emotions from physiological signals. The system can't differentiate between internal and external emotion. Therefore, an integrated approach of physiological and facial emotion recognition is required in an emotion recognition framework.

M.T. Quazi et al. [23] demonstrated a smart sensing system detects human emotions based on bodily parameters, the amplified and filtered signals from the sensors are then processed by a microcontroller and transmitted wirelessly using Zigbee technology, received signal then displayed on a computer, the partially developed system has demonstrated nice outcomes in observing the bodily parameters. The only drawback of the discussed system is that it can visualize the effect of only four emotions happy, sad, angry and neutral.

Eun-Hye Jang et al. [24] introduced a paper; it illustrated the differences between boredom, pain, and surprise by using bodily signals. The exploration in the paper could dedicate to enhance the sensibility of human feeling states and the basic bodily system. By revealing human's emotional reply features from different groups, the findings could dedicate to anthropology. But the limitation of this paper, bodily signals can only recognize inner feelings.

Kathawut Rojanasaroch et al. [25] introduced an easy, cheap communication aid device for a consult with a doctor by deaf-dumb, the system includes the steps: selection of images, transform the image to the pattern, comparison and pair with words, form sentences, send a corresponding sentence to display. The device act as an interpreter between deaf-dumb and the doctor. The device dedicated to communication with a doctor by deaf –dumb during illness. The communication mode is simplex because device operates in one way and the sender is deaf –dumb and receiver is a doctor.

TobiiDynavox [26] introduced the new TobiiDynavox I-Series+ speech generating device along with Communicator 5 software. Trained eye tracking users can easily point over letters to form words they want to write. This has the ability to boost communication speed prominently for users because slow speed is the drawback of speech generating devices. I-Series+ devices with touch screen and alternative eye tracking capabilities provide communication such as SMS, social networking, electronic mail, phone calls, etc. The letter or word displays on the screen of TobiiDynavox I-Series+ with associated pictures of that word so that the user can clearly understand them (e.g. Hand word with a picture of a hand). However, the output speech is not expressive from this device and expressive speech is that which can convey emotion. Mingmin Zhao et al. [27] introduced an emotion recognition system using the wireless signal as EQ-Radio. It acts by emitting a radio frequency signal and obtaining its reflections off an individual's body. But such a system can be implemented over the human body for a small time, for example- x-ray. The human body can't bear radio signal continuously because radio waves harm the human body. So where we required continuous emotion recognition this system is not appropriate. Elena Simion [28] introduced a paper on augmentative and alternative communication (AAC) and discussed that whenever a kid's speech does not develop generally or he cannot communicate efficiently through speech due to pre-existing situations, it is suggested to receive AAC support as soon as possible. Janice Light and David McNaughton [29] introduced an article on augmentative and alternative communication (AAC) and discussed that since these early days of AAC the area has observed dramatic changes:

i. Changes in the population that uses AAC.

ii. Changes in the range of communication require that must be considered.

iii. Changes in the AAC systems that are available.

iv. Finally, changes in expectations for participation by persons who use AAC.

Jeff Sigafoos [30] introduced an article on augmentative and alternative communication (AAC) and discussed that AAC refers to a field of exploration and clinical specialization that spans several disciplines, containing assistive technology, psychology, rehabilitation, special education, and speech-language pathology. AAC exploration has included a broad range of subjects; from developing recent and more efficacious methods of executing AAC, to examine the effects of AAC use, to evaluating innovative assistive communication technologies. Clinical practice in AAC is largely related to enabling people with limited speech and language to communicate using one or more options for speech. AAC frameworks are also often used to enhance unintelligible speech. The exploration revealed that people with Autism Spectrum Disorder or intellectual disability might be able to self-decide which of many AAC alternatives should be incorporated into their AAC interference.

FINDINGS

Augmentative and alternative communication has identified as an active exploration field and it is beneficial for disabled people so that they can live a better life. The problem faced by the

disabled in terms of assessment of communication requires, communication opportunity: cognitive/linguistic and capability assessment: sensory/perceptual has identified.

But, in the present scenario, the major problems faced by speech disabled person are:

1. Price of the device: - Many supporting devices are available for speech disability but the cost is high that can't be bearable for a disabled person.

2. Unavailability of Natural Speech: The speech generated from the devices is not natural, a disabled person feels uncomfortable with synthetic speech.

3. Limitation of words and phrases: Many devices have the limitation of words and phrases; a disabled person can express only a few sentiments with limited words e.g. Go Talk Pocket, Logan Prox Talker, Mega Bee Eye Pointing Communication Tablet.

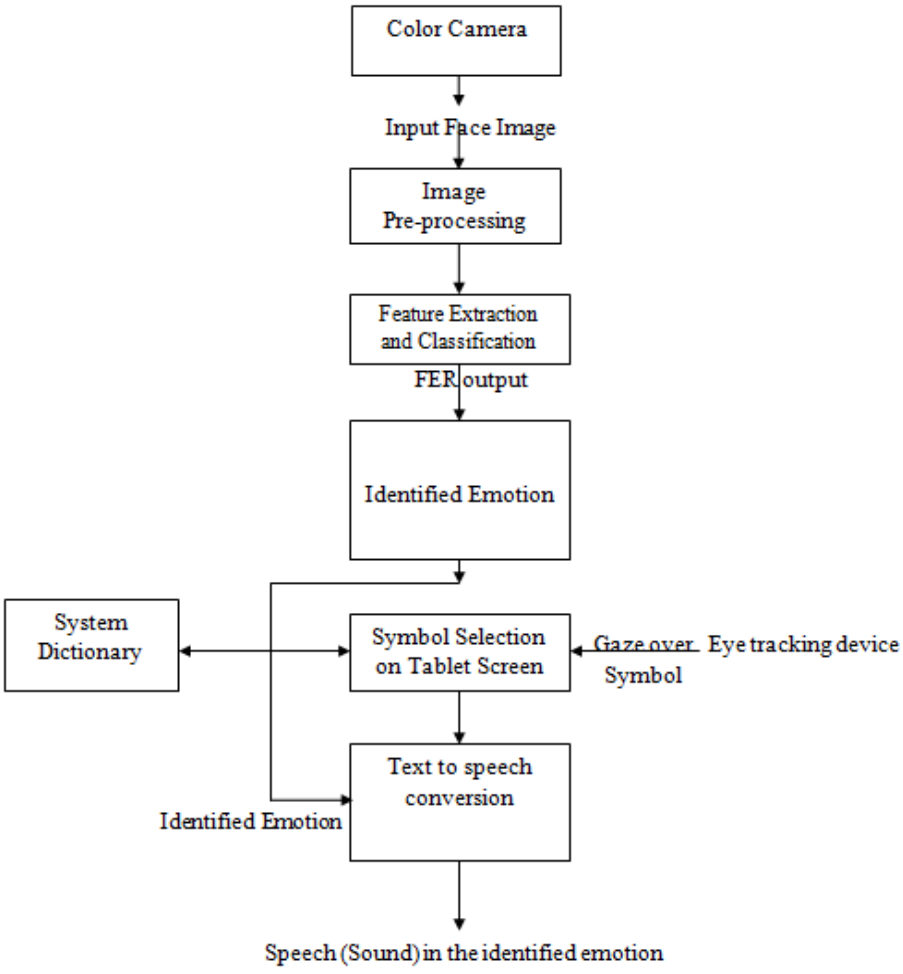
Communication is very important for human life and this knowledge can be utilized in the development of perfect devices for speech-disabled persons. Here are few products available (Table 6.1) to support speech disability and used as an alternative communication tool by speech disabled person.

Year	Company/ Author	Device/ Framework	Price	Key Features	Drawback
2012	Attainment Company	Go Talk Pocket[31]	$ 189.00	The small device can store 30 messages in five levels, on six buttons.	Limitation of words and sentences, output voice is not expressive and it is prerecorded.
2012	Logan Tech	Logan Prox Talker[32]	$ 3149.00	1. It enables independent verbal picture communication using radio frequency identification (RFID) technology. 2. Put your sound tag card on any one of the five buttons and push to get output voice. A male or female voice can select as the output.	This product has a limitation of words and this device makes the voice of prerecorded RFID tags but cannot produce sentences.
2013	Logan Tech	Mega Bee Eye Pointing Communication Tablet[33]	$ 1595.00	Dual screens accommodate 20 characters in two lines.	The device has a limitation of words and sentences; the output speech is not expressive.
2014	Beamz Interactive Inc.	Beamz Music System[34]	$ 600.00	1. W-shaped tabletop optical control device with several laser beams. 2. Beamz system connects to a computer via USB. 3. Six lasers trigger and 2 buttons controlled triggers activate up to 64 freely controlled orders of musical notes or events.	This is a musical system used for entertainment of disabled persons, not a speech-generating device.
2015	TobiiDynavox	TobiiDynavox I-Series+[35]	£ 8,967.00	By using eye-tracking technology this can support communication such as email, text messaging, social networking, phone calls.	The output speech is not expressive from this device and expressive speech is that which can convey emotion.

[**Table: 6.1:-**Different speech generating devices]

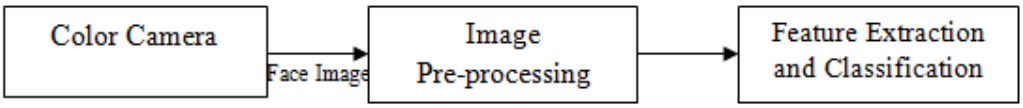
PROPOSED FRAMEWORK

The problem of speech disability has identified, augmentative and alternative communication has recognized as a good resolution. Few of the current AAC support devices or frameworks have been studied; the problem of high cost, expressivity, and limitation of words and phrases has been identified. So, the objective of the proposed framework (named as aawaj) is to overcome the problem of expressivity, high-cost, and limitation of words and phrases. Because present speech generating devices is less expressive and the cost is very high that is not bearable by a disabled person. The proposed framework is divided into three modules: facial emotion recognition, symbol selection and text to speech conversion. The limitation of the proposed system is that it can't work efficaciously for the users those can't express facial expressions.

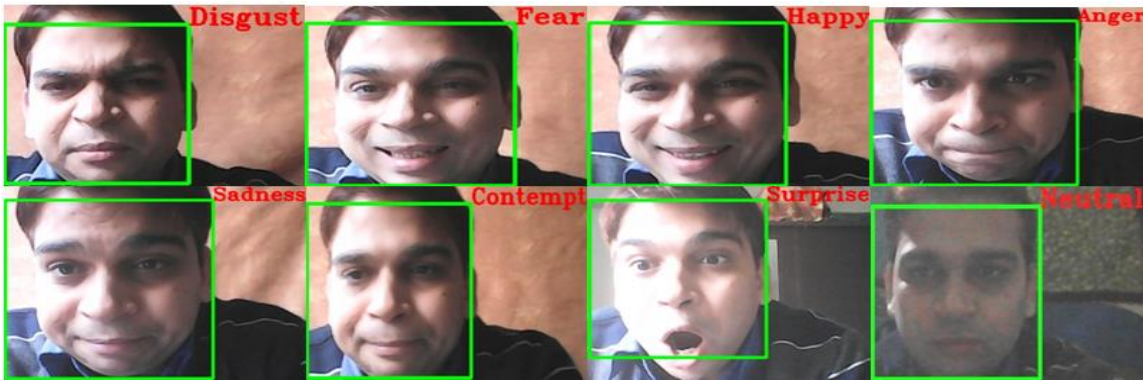


[**Fig6.3:** Architecture of proposed framework]

Module A (Facial emotion recognition): Module A recognizes eight basic emotions- Contempt, Fear, Happy, Sad, Surprise, Disgust, neutral and anger. G.J. Edwards et al. [36] exhibited a rapid, durable scheme of interpretation of face images using an Active Appearance Model (AAM); it is a repetitive process for fitting an AAM to face images. An AAM includes a computation model of shape and grey level appearance which can generalize to approximately any face.



[**Fig6.4:**-Module A]



[**Fig6.5:**-Module A- recognition of eight basic emotions]

Steps of Module A:

1. Find the facial area using active appearance modeling (AAM)

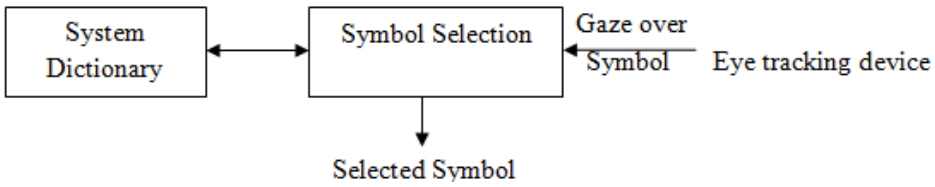
2. The image conversion into a Gabor magnitude representation, using a bank of Gabor filters at 8 orientations and 5 spatial frequencies (4:16 pixels per cycle at 1/2 octave steps)

3. Mark the Facial points: Feature selection algorithm

4. Feature extraction: Action unit detection algorithm

5. Classification: Support vector machine

Module B(Symbol Selection)- Disabled user selects the target symbol using the onscreen keyboard, and form the sentences, which he want to speak.



[**Fig6.6:**-Module B]

[**Fig6.7:**-Module B- text editor]

Steps of Module B:-

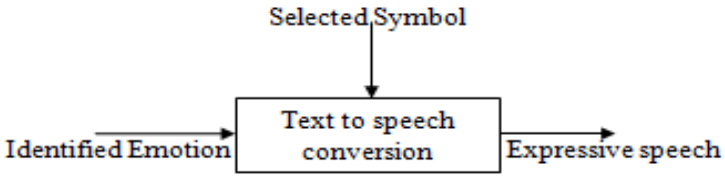
1. Display alphabets A to Z digits 0-9 and another symbol over the onscreen keyboard.

2. Select letter, digit, and another symbol using an eye tracking device.

3. Form the sentences.

4. Send the sentences to module C for text to speech conversion.

Module C(Text to speech Conversion): Module C convert text to speech in the form of identified emotion. The output voice can be chosen as a male voice or female voice. The voiced speech of a general adult male has a basic frequency from 85 to 180 Hz and that of a general adult female from 165 to 255 Hz.



[**Fig6.8:**-Module C]

Steps of Module C:

1. Standard Text Editor

2. Text Normalizer

3. Grammar Dictionary

4. Letter-to-phoneme rules

5. Prosody rules

6. Phonetic rules

7. Emotion Insertion

8. Voice generation

9. Interrupt driver

10. Output hardware

The preliminary test:

As an experiment to test and verify the validity of the partially developed proposed communication aid framework, a preliminary test was done without the eye-tracking device. The test includes a naturalness test, intelligibility test, accuracy test, and comprehensibility test. The outcomes of the test are given below.

a. Naturalness Test:

Mean opinion score and Degraded Mean Opinion Score are calculated to test and verify the naturalness of the output speech.

Mean Opinion Score (MOS):

MOS is the easiest manner to evaluate the quality of output speech. MOS gives a numerical sign of the quality of the output speech. In this manner, the main concern of evaluator should be on the naturalness of synthetic speech. Naturalness means that the voice is indistinguishable from human speech, and it is identical to human voice [37]. The naturalness aspect of synthesized speech will have to be understood by the evaluator, after hearing to the output voice. MOS is the average of the scores given by all the evaluators.

MOS	Quality of speech
5	Excellent
4	Good
3	Fair
2	Poor
1	Bad

Calculation of MOS: Test Data for MOS should contain a short paragraph that included all the possible variations primely: symbols, numerals, abbreviations, English words written in Latin and Indian scripts, and various types of sentences such as negative, declarative and exclamatory. Sentences chosen from various fields such as stories, news, sports, etc.

$$MOS=\frac{\sum_{j=1}^{M}\left(\frac{\sum_{i=1}^{N} Sij}{N}\right)}{M}$$

Si=Score of the ith evaluator
N=Total number of Evaluators
M=Total number of Sentences
J= Index of sentence

Evaluator	*Score Given*																			
	S1		S2		S3		S4		S5		S6		S7		S8		S9		S10	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Evaluator 1	3	4	4	3	2	3	4	4	4	4	3	3	4	3	5	4	3	2	3	3
Evaluator 2	4	4	2	3	2	2	4	3	5	4	3	3	4	4	4	4	4	4	5	5
Evaluator 3	5	3	3	5	4	4	4	5	5	5	4	4	5	5	3	3	2	2	5	5
Evaluator 4	4	3	4	4	3	3	3	4	3	3	3	3	4	4	3	3	3	4	4	4
Evaluator 5	5	3	4	2	4	4	4	5	5	5	3	4	5	5	4	4	5	5	5	4
Evaluator 6	4	3	4	4	3	4	3	4	3	5	2	3	5	5	4	4	4	4	5	4
Evaluator 7	4	4	4	4	4	4	3	4	4	4	3	3	5	5	3	3	4	4	3	4
Evaluator 8	4	2	4	3	4	5	3	4	5	4	3	3	5	4	3	3	4	4	5	4
Evaluator 9	3	3	3	2	3	3	4	4	3	4	3	4	4	5	3	3	2	3	3	4
Evaluator 10	5	3	4	3	3	4	5	4	4	4	4	3	5	5	3	4	3	4	5	4
Total	**41**	**32**	**36**	**33**	**32**	**36**	**37**	**41**	**41**	**42**	**31**	**33**	**46**	**45**	**35**	**35**	**34**	**36**	**43**	**41**

[**Table 6.9:**-MOS for naturalness]

Maximum Score=5

For Male voice, MOS Score = 3.76

MOS Score percentage = 75.2

For Female Voice, MOS Score = 3.74

MOS Score percentage = 74.8

Degraded Mean Opinion Score (DMOS):

DMOS score is used to evaluate the naturalness aspect of the output voice by comparing the natural and synthetic speech. In a DMOS manner, evaluators required to listen to synthetic as well as a natural speech in random order, without having earlier information about the type of speech i.e. synthetic or natural. The objective of this manner is to evaluate the speech in terms of naturalness. Mean of scores given to natural and synthesized speech separately by each evaluator will be computed [38].

$$\text{Standardized score of synthesized to natural} = \frac{\text{synthetic speech score}}{\text{natural speech score}} * 5$$

Score of Naturalness

5	Framework sound like Human
4	Robotic sound but reading properly
3	Reading sentences with less broken words in a robotic style
2	Approximately every word broken
1	Very intolerable

[**Table 6.10:**-DMOS]

Evaluator	**Score Given**			
	Synthetic		**Natural**	
	M	**F**	**M**	**F**
Evaluator 1	3.5	3.3	4	5
Evaluator 2	3.7	3.6	5	4
Evaluator 3	4	4.1	5	5
Evaluator 4	3.4	3.5	4	5
Evaluator 5	4.4	4.1	5	4

Evaluator 6	3.7	4	4	5
Evaluator 7	3.7	3.9	5	4
Evaluator 8	4	3.6	4	5
Evaluator 9	3.1	3.5	5	5
Evaluator 10	4.1	3.8	5	5
Total	**37.6**	**37.4**	**46**	**47**

Normalized score of synthesized to natural,

Male Voice =4.086

Female Voice=3.97

Intelligibility Test:

Intelligibility tests are one of the crucial factors affecting speech quality. We can compute intelligibility of speech by MOS and WER.

Mean Opinion Score (MOS):

Intelligibility refers to the precision with which every word is pronounced so that the general listener can understand the meaning of the spoken word or phrase. In this manner, the attention of evaluator should be on the intelligibility of synthetic speech.

$$MOS=\frac{\sum_{j=1}^{M}(\frac{\sum_{i=1}^{N} Sij}{N})}{M}$$

Si=Score of the ith evaluator
N= Total number of Evaluators
M=Total number of Sentences
J=Index of Sentence

Evaluator	*Score Given*																			
	S1		S2		S3		S4		S5		S6		S7		S8		S9		S10	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Evaluator 1	4	4	3	3	3	3	4	3	4	3	3	3	4	3	3	3	4	4	4	4
Evaluator 2	4	4	3	3	3	3	3	3	4	4	3	3	4	4	4	4	4	4	4	4
Evaluator 3	4	4	5	5	4	4	4	4	5	5	4	4	5	5	2	2	4	4	5	5
Evaluator 4	4	4	3	3	3	3	4	4	4	4	3	4	4	4	3	2	3	4	4	4
Evaluator 5	4	4	5	5	4	5	4	4	5	5	3	4	5	5	4	4	5	5	5	4
Evaluator 6	5	5	4	4	3	3	3	4	5	4	3	3	5	5	4	4	5	5	5	5
Evaluator 7	4	4	4	4	3	3	3	3	4	4	3	4	5	5	4	4	4	4	5	5
Evaluator 8	4	4	4	3	4	4	5	4	4	4	4	4	5	5	3	3	5	5	5	5
Evaluator 9	3	3	3	3	3	4	4	4	4	4	3	3	4	5	3	2	4	4	4	4
Evaluator 10	4	3	4	4	5	4	4	4	5	5	4	3	5	4	4	3	5	5	5	4
Total	**40**	**39**	**38**	**37**	**35**	**36**	**38**	**37**	**44**	**42**	**33**	**35**	**46**	**45**	**34**	**31**	**43**	**44**	**46**	**44**

[**Table 6.11**:-MOS for intelligibility]

Maximum Score=5

For Male voice, MOS Score = 3.97,

MOS Score percentage = 79.4

For Female Voice, MOS Score = 3.9,

MOS Score percentage = 78

ii. Word Error Rate (WER):

For this test, sentences which are semantically not understandable (SNU) but are formed in such a way that they are grammatical should be used. Word length of SNU sentences should not exceed by 7; because possibilities are that evaluators might forget them. SNU is used to judge intelligibility because it becomes hard for listeners to predict unheard information. After hearing a sentence, the evaluator will have to write whatever they heard, even if they don't understand the meaning. While computing WER, writing mistakes should be avoided [39].

For every evaluator,

$$\text{WER}=\frac{(A+B+C)}{D}$$

Where,

A is the no. of changes

B is the no. of deletions

C is the no. of insertions

D is the total no. of words in the Sentence

Evaluator	WER										
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	Total
Evaluator 1	0.14	0	0.14	0.125	0.14	0	0	0.33	0	0.5	1.375
Evaluator 2	0.28	0.33	0.42	0.25	0.42	0	0	0.66	0	1	3.36
Evaluator 3	0	0.16	0.42	0	0	0	0	0.33	0	0	0.91
Evaluator 4	0.14	0.5	0.14	0	0	0	0.66	0.66	0	0.5	2.6
Evaluator 5	0.28	0.16	0.14	0	0	0	0	0.33	0	0	0.91
Evaluator 6	0.28	0.5	0.14	0	0.14	0	0	0.33	0	0.5	1.89
Evaluator 7	0.28	0.33	0.14	0	0	0	0	0.33	0	0.5	1.58
Evaluator 8	0.28	0.66	0.28	0	0	0	0	0.33	1	0.5	3.05
Evaluator 9	0.28	0	0.14	0	0.14	0	0	0.66	0	0.5	1.72
Evaluator 10	0.28	0.16	0.28	0	0	0	0	0	0	1	1.72

[Table 6.12:-WER]

Average WER =1.9115

Accuracy Test:

For accuracy computation suitable selection of test data is important. All such data whose required output is well defined can be chosen for the accuracy test. Classification of test data is as follows:

[**Table 6.13:**-Test Data]

Test Data	Performance	Score
a) Number Handling i. Digits (Phone no. +91-9456249716) ii. Fractions (1/2) iii. Numbers (9999) iv. Numerals (1st, XI)	Excellent	5
b) Date formats (MM/DD/YY)	Excellent	5
c) Acronyms (prof., Dr., Rs. ,etc.)	Bad	1
d) Abbreviations (DRDO, PWD,SBI)	Excellent	5
e) Names(Pradeep Kumar Kaushik)	Good	4
f) Addresses(E-135,Janakpuri ,Sahibabad ,Ghaziabad)	Good	4
g) Homographs(redress-regress)	Excellent	5
h) Punctuations and Brackets (, ; " " – [],(),{})	Bad	1
i) Special Symbols ($, @, %)	Excellent	5

Score	Quality of Speech
5	Excellent
4	Good
3	Fair
2	Poor
1	Bad

$$\text{Accuracy}=\frac{Sum\ of\ Score}{Total\ of\ Maximum\ Score}\ *100$$

$$\text{Accuracy}=\frac{35}{45}*100=77.77\%$$

Comprehensibility Test(CT):

Intelligibility test focuses only on the recognition of every word without a focus on the meaning of the sentence. CT evaluates the complete sentence. CT carried out when the framework achieves the intelligibility up to admissible level else it is meaningless to carry out CT for the unintelligent framework; as intelligibility has a strong effect on comprehension [40].

In the CT, the evaluator will be asked to hear a paragraph and based on that few questions will be asked. Questions should be framed in such a way that whether the evaluator has understood the paragraph listen or not can be observed.

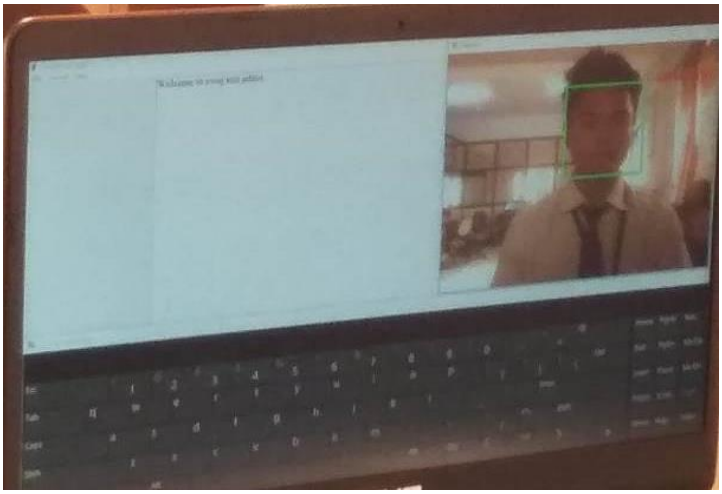
A two-point scale (0, 1) is suggested for the CT.

Scale	Evaluation
0	Incorrect answer
1	Correct answer

[**Table 6.14:** Comprehensibility test]

Evaluator	Score Given
Evaluator 1	1
Evaluator 2	1
Evaluator 3	1
Evaluator 4	1
Evaluator 5	0
Evaluator 6	0
Evaluator 7	1
Evaluator 8	0
Evaluator 9	1
Evaluator 10	1

Comprehensibility test Result:-70%



[Fig 6.15:- The preliminary test]

CONCLUSION

In the introduced work, the type of disability has discussed and speech disability chosen as the centre of exploration; augmentative and alternative communication has found as a good resolution to speech disability. An important application of facial emotion recognition and eye tracking technology has been identified in speech disability support frameworks. A number of devices are available and few with the eye tracking capability, but the cost is very high, and these are less expressive. So, lack of an expressive device is found but our objective is to find a real-time expressive communication framework dedicated to the speech disabled person and different already developed devices have studied and Simplex mode is best suited for communication, because the system will be used by speech disabled to express their feelings, and that will be unidirectional communication. Therefore, there is a requirement for an expressive communication system for a speech-disabled person in simplex mode. That's why the design of the proposed framework is prepared in this paper. The preliminary test is performed in the lab to ensure the efficiency of the proposed framework; the above results in different metrics have shown the efficiency is 70 percent or more.

FORTHCOMING WORK

The cost of the current speech generating devices is very high and output speech is not expressive, both recognized as a major problem, so it is recommended that low cost and expressive speech generating device or framework should be developed in future. In the future, this is going to be a significant development until a full proof and cost-efficacious system for efficaciously interpreting the sentiments of speech disabled can be developed. In the future, the efficiency of the proposed framework will be increased, and the complete system will be tested with an eye-tracking device.

REFERENCES

[1] "World Health Organization-Health topics - Disabilities" [Online] Available: https://www.who.int/topics/disabilities/en/
[2] "International Classification of Functioning, Disability and Health" [Online] Available: https://www.who.int/classifications/icf/en/
[3] "World report on disability" [Online] Available: https://en.wikipedia.org/wiki/World_report_on_disability
[4] Surbhi Rathi, Ujwalla Gawande, "Development of full-duplex communication system for deaf and dumb people", 7th International conference on cloud computing, data science, and engineering-Confluence, IEEE 2017
[5] Pet Mirenda, Teresa lacono, "Communication Options for Persons with Severe and Profound Disabilities: State of the Art and Future Directions", sage journals, Vol.15, issue: 1, pages: 3-21, March 1990.
[6] Barry M. prizant, Lisa R. Audet, Grace M. Burke, Lauren J. Hummel, Suzanne R. Maher, Geraldine theadore, "Communication Disorders and Emotional/Behavioral Disorders in Children and Adolescents", Journal of speech and hearing disorders, May 1990, Vol.55,179-192.
[7] "Emotion Recognition" [Online] Available: https://en.wikipedia.org/wiki/Emotion_recognition
[8] Salwa Said, Olfa Jemai, Mourad Zaied, Chokri Ben Amar, "Wavelet Networks for Facial Emotion Recognition", 15th International Conference on Intelligent Systems Design and Applications (ISDA), IEEE 2015.
[9] Priya Saha, Debotosh Bhattacharjee, Barin Kumar De, MitaNasipuri, "An Approach to Detect the Region of Interest of Expressive Face Images", International Conference on Information and Communication Technologies (ICICT 2014), Elsevier Procedia Computer Science 46(2015)1739-1746.
[10] Jyoti Kumari, R.Rajesh, K.M Pooja, "Facial expression recognition: A survey", Second International Symposium on Computer Vision and the Internet (VisionNet'15), Elsevier Procedia Computer Science 58(2015), 486-491

[11] Ma Xiaoxi, Lin Weisi, Huang Dongyan, Dong Minghui, Haizhou Li, "Facial emotion recognition", 2nd International Conference on Signal and Image Processing (ICSIP), IEEE, Aug 2017 DOI: 10.1109/SIPROCESS.2017.8124509

[12] Mohan Ghai, Shamit Lal, Shivam Duggal, Shrey Manik, "Emotion recognition on speech signals using machine learning", International Conference on Big Data Analytics and Computational Intelligence (ICBDAC),2017.

[13] Roshan Jameel, Abhishek Singhal, Abhay Bansal, "A Comprehensive study on facial expressions recognition techniques", 6th International Conference –Cloud System and Big data Engineering (Confluence), IEEE2016.

[14] Ligang Zhang, Dian Tjondronegoro, "Facial expression recognition using facial movement features", IEEE Transactions on Affective Computing, Vol.2, Issue No.4,2011, **DOI:** 10.1109/T-AFFC.2011.13

[15] Shoaib Kamal, Dr. Farrukh Sayeed, Mohammed Rafeeq, "Facial Emotion Recognition for Human-Computer Interactions using hybrid feature extraction technique", International Conference on Data Mining and Advanced Computing (SAPIENCE), IEEE, March 2016, **DOI:** 10.1109/SAPIENCE.2016.7684129

[16] Pawel Tarnowski, Marcin Kolodziej, Andrzej Majkowski, Remigiusz J. Rak, "Emotion recognition using facial expressions", International Conference on Computational Science, ICCS 2017,12-14 June 2017, Zurich Switzerland, DOI: https://doi.org/10.1016/j.procs.2017.05.025

[17] Md. Zia Uddin, Weria Khaksar, Jim Torresen, "Facial expression recognition using salient features and convolutional neural network", Vol. 5, IEEE Access, Nov 2017, DOI: 10.1109/ACCESS.2017.2777003

[18] Pramodini A. Punde, Mukti E. Jadhav, Ramesh R. Manza, "A study of eye tracking technology and its applications", 1st International Conference on Intelligent Systems and Information Management (ICISIM), IEEE, Oct 2017.

[19] Amer Al-Rahayfeh, Miad Faezipour, "Eye Tracking and Head Movement Detection: A State-of-Art Survey", IEEE Journal of Translational Engineering in Health and Medicine (Volume: 1), DOI:10.1109/JTEHM.2013.2289879

[20] Shaun K. Kane, Meredith Ringel Morris, Ann Paradiso, Jon Campbell, "At times avuncular and cantankerous, with the reflexes of a mongoose: Understanding Self-Expression through Augmentative and Alternative Communication Devices", Proceedings of CSCW 2017, ACM, DOI: http://dx.doi.org/10.1145/2998181.2998284

[21] Alexander Fiannaca, John Campbell, Ann Paradiso, Meredith Ringel Morris, "Voice setting: Voice Authoring Uis for Improved Expressivity in Augmentative Communication", Proceedings of CHI 2018, ACM.

[22] Christos D. Katsis, Nikolaos S. Katersidis, Dimitrios I. Fotiadis, "An integrated system based on physiological signals for the assessment of affective states in patients with anxiety disorders", Biomedical Signal Processing and Control 6(2011)261-268, Elsevier.

[23] M.T.Quazi, S.C. Mukhopadhyay, N.K.Suryadevara, Y.M. Huang, "Towards the Smart Sensors Based Human Emotion Recognition", International Instrumentation and Measurement Technology Conference (12 MTC), IEEE 2012, DOI: 10.1109/12MTC.2012.6229646

[24] Eun-Hye Jang, Byoung-Jun Park, Mi-SookPark, SngHyeobKim, Jin Han Sohn, "Analysis of physiological signals for recognition of boredom, pain and surprise emotions", Journal of Physiological Anthropology (2015)34:25

[25] Kathawut Rojanasaroch, Terravisit Laohapensaeng, "Communication Aid Device for Illness Deaf-Mute", 12th International Conference on Electrical Engineering/Electronics, Computer, Telecommunications, and Information Technology (ECTI-CON), IEEE2015, DOI:10.1109/ECTICon.2015.7207127

[26] "TobiiDynavox I-Series+" [online] Available: https://www.tobii.com/group/news-media/press-releases/tobii-dynavox-launches-the-new-i-series-and-communicator-5-for-even-more-efficient-communication/

[27] Mingmin Zhao, Fadel Adib, Dina Katabi, "Emotion recognition using wireless signals", MobiCom'16 Proceedings of the 22nd Annual International Conference on Mobile Computing and Networking, ACM, Oct 2016.

[28] Elena Simion, "Augmentative and alternative communication - support for people with severe speech disorders", Procedia – Social and Behavioral Sciences, Vol. 128, April 2014, Pages 77-81.

[29] Janice Light and David McNaughton (2012), "The Changing Face of Augmentative and Alternative Communication: Past, Present, and Future Challenges", Augmentative and Alternative Communication, 28:4, 197-204.

[30] Jeff Sigafoos, Mark F. O. Reilly, Giulio E. Lancioni, Dean Sutherland, "Augmentative and Alternative Communication for Individuals with Autism Spectrum Disorder and Intellectual Disability", Springer International Publishing, Jan 2014, Online ISSN: 2196-2987, DOI: https://doi.org/10.1007/s40474-013-0007-x

[31] "Attainment Go Talk Pocket" [Online] Available: https://www.enablemart.com/attainment-gotalk-pocket.

[32] "Logan Prox Talker" [Online] Available: https://logantech.com/products/proxtalker

[33] "MegaBee Eye Pointing Communication Tablet" [Online] Available: https://logantech.com/products/megabee
[34] "Beamz Interactive Music System" [Online] Available: https://www.inclusivetlc.com/beamz-interactive-music-system
[35] "Tobii Dynavox I-Series+" [Online] Available: https://www.tobiidynavox.com/devices/eye-gaze-devices/i-15-with-communicator/
[36] G.J. Edwards, C.J. Taylor, T.F. Cootes, "Interpreting face images using active appearance models", Proceedings Third IEEE International Conference on Automatic Face and Gesture Recognition,1998, DOI:10.1109/AFGR.1998.670965
[37] "ITU-T Rec. P 800 (08/96) Methods for subjective determination of transmission quality" [Online] Available: https://www.itu.int/rec/T-REC-P.800-199608-I/en
[38] Viswanathan Mahesh and Viswanathan Madhubalan (2005), "Measuring speech quality for text-to-speech systems: Development and assessment of a modified mean opinion score (MOS) scale", Computer Speech and Language-Elsevier, 19(1): 55-83.
[39] Black Alan W. and Tokuda Keiichi, "The Blizzard Challenge 2005: Evaluating corpus-based speech synthesis on common datasets", Conference: INTERSPEECH 2005,77-80 - Eurospeech, 9th European Conference on Speech Communication and Technology, Lisbon, Portugal, September 4-8, 2005
[40] Yu Yun Chang, "Evaluation of TTS systems in intelligibility and comprehension tasks", ROCLING '11 Proceedings of the 23rd Conference on Computational Linguistics and Speech Processing Pages 64-78, Taipei, China-September 08-09, 2011
[41] Pradeep Kumar Kaushik, Shivam Pandey, Sushil Singh Rauthan , "Facial Emotion Recognition and Eye-tracking based Expressive Communication Framework: Review and Recommendations", International Journal of Computer Applications, Volume 184 - Number 39, 2022.

CHAPTER-6.5

Elimination of Article 370 from Jammu and Kashmir: Analysis of Elimination in Terms of Business Point of View

Pradeep Kr. Kaushik[1], Sushil Singh Rauthan[2], Manoj Kr. Chaudhary[3], Suraj Sinha[4]
[1]Assistant Professor, JB Institute of Technology Dehradun
[2]Assistant Professor, JB Institute of Technology Dehradun
[3]HOD (CSE), JB Institute of Technology Dehradun
[4]Assistant Professor, JB Institute of Technology Dehradun

ABSTRACT: *Indian authorities have eliminated the disputed article-370 from Jammu and Kashmir. This article was a barrier among the people of Jammu and Kashmir and rest of India. This paper provides the effective impact of the abolition of article 370 from Kashmir from the investment point of view due to the fact the state has a loss of jobs; local young people go to other states in search of jobs.*

Keywords-Tourism zone, Agriculture and dairy zone, manufacturing industry

INTRODUCTION

Recently, the Indian authorities determined to take away the article 370 from Kashmir. Article-370 of the Indian constitution gave special status to the area of Jammu and Kashmir, permitting it to have a separate constitution, a nation flag and autonomy over the inner administration of the nation [1], however because of this article the state progress stopped, because the investment rate become very gradual as required to meet the present-day demand of locals.

INVESTMENT OPPORTUNITY IN JAMMU AND KASHMIR

Jammu and Kashmir has many possibilities of investment in distinct sectors; this funding can provide many job opportunities to locals of this state. In step with the document "Investments in J&k can be now a top schedule in many company boardrooms. In the next five years, the adolescents in the region will gain from notable job opportunities due to those investments," stated Puneet Dalmia, MD, Dalmia Bharat group [2].

TOURISM SECTOR

Tourism sector was the spine of this state since the independence of India but the continuous terrorist activity from Pakistan badly affected this region, as an instance, houseboats business is nearly finished.

SPIRITUAL TOURISM

This state has famous spiritual locations of Hindus sh. Vaishno Devi holy cave, Sh Amarnath holy cave, Martand sun Temple in Anantnag, Khirbhavani Mandir in Ganderbal Jaya Devi Temple, Bijbehara historic Hanuman temple in Srinagar, Gautam Nag Temple in Anantnag and two hundred years old Ganpatyar Temple in Srinagar, each 12 months many people come in this state due to spiritual tourism and after the abolition of article 370, the number of

pilgrims will boom.

NON-SPIRITUAL TOURISM

This nation has many obviously beautiful places -Bahu castle, Mubarak Mandi Palace, Mansar Lake, Lamayuru -Moonland of Ladakh, Pangong Lake, Nubra Valley, Gulmarg, and Pahalgam, etc. After the abolition of article 370 this region will get a boost because due to this investment in resorts and restaurant will increase.

AGRICULTURE AND DAIRY SECTOR

This state has lots of investment opportunity in the agriculture area. Fruits, vegetables and dry fruits are majorly produced in the agriculture zone, after the abolition of article 370, this area will get a lift and the income of poor will boom. In conjunction with the agriculture area, the dairy area can even get a lift. in line with the document "For years, J&k's dairy sector has been beset by way of demanding situations of low remuneration, expensive milk production, competition from non-public dairy players, and farmers losing interest in animal husbandry. Source- The Hindu" [3].

MANUFACTURING INDUSTRY

This area has many sub-sectors and this area constantly has funding possibility, this sector generates services and goods. According to reports - "We suppose it will kick start with the corporations tying up with set up local investors to build the environment. This is how maximum cities and states develop and we see it as a high-quality opportunity for localities first. We plan to give you the manufacturing facility according with the upcoming investor summit within the month of October. We are hoping the choices will permit the organizations to operate freely under the same guidelines within the valley", said Rajeev Kapur, MD, Steelbird Helmets [4].

"The revoking of Article 370 will help the J&k economic system for certain. The stagnation that the state financial system has suffered for decades can be reversed. Additionally, its miles a boon for students as well across India who wishes to seek employment within the valley and through our plant, we will be generating employment as nicely." added Mr. Rajeev Kapur [4].

1) Food processing and packed water enterprise- This state has lots of funding possibility in food/fruits processing because products of agriculture zone want to be processed and packed water enterprise may be set up in the state due to the fact the state has many rivers.

2) Film industry- This state has natural beauty so the state has plenty of locations which can be used for film shooting and the state government gets revenue.

3) pharmaceuticals industry-This state is located within the Himalayan area, so many herbs can be grown here and later that can be utilized in pharmaceuticals enterprise and may be sold anywhere inside the country.

4) Fabric enterprise- The state has a lot of opportunity inside the fabric industry, the woolen

cloths are well-known and have great demand within the north Indian marketplace, and after the abolition of 370 this sector will get a boost.

COMPARISON WITH DIFFERENT UNION TERRITORIES

India has many union territories some of them are with the legislature and some of them are without a legislature, and some Union territories have transformed into states. As we know, the statement of cutting-edge domestic minister of India Mr. Amit Shah in Rajya Sabha, Jammu and Kashmir can be transformed within the state after getting stability.

Union territories without their own legislatures [5]:

- Chandigarh
- Dadra and Nagar Haveli
- Daman and Diu
- Lakshadweep
- Ladakh (proposed from 31 October 2019)
- Andaman and Nicobar Islands

Union territories with their own legislatures [5]:

- Jammu and Kashmir (proposed from 31 October 2019)
- Puducherry
- National Capital Territory of Delhi

Former union territories (Currently States) [5]:

- Arunachal Pradesh (1972–1987)
- Goa, Daman and Diu (1961–1987)
- Himachal Pradesh (1956–1971)
- Manipur (1956–1972)
- Mizoram (1972–1987)
- Nagaland (1957–1963)
- Tripura (1956–1972)

We are able to take an example of Goa, it's far a small state and Goa has the highest NSDP per capita (₹ 420,383(US$6,100)) amongst all Indian states, and if we have a look at Sikkim and Chandigarh are small states/union territory however hold more rank than massive states/union territory, so it's far clear that a small country or union territory can grow, and it requires a terror-free surroundings. another crucial concern is that Kashmir trade was being used for illegal cash transfer (hawala) to fund terrorist activity by Pakistan and this illegal money transfer had to prevent but felony exchange and economic activity need to increase

this can be achieved simplest by using remove article 370, so the Abolition of article 370 is in the favor of people of Jammu and Kashmir.

CONCLUSION

As we know the Kashmir Apple and pashmina sholl, have demand in the Indian marketplace, this state has lots of funding opportunity however article 370 was the massive obstacle of country progress. This turned into essential to be removed for the prosperity of the state. The 5 Aug 2019 nowadays has been recorded inside the history, the abolition of Article 370 will convey happiness inside the lifestyles of nearby people, they'll get job, there in line with capita income will be elevated, the GDP contribution of the country, will boom, so after the general evaluation, we are able to say the state might be the happiest state of the Republic of India.

REFERENCES

[1] "Article 370 of the Constitution of India"
[2] [Online] Available: https://en.wikipedia.org/wiki/Article_370_of_the_Constitution_of_India
[3] "India Inc sees investment opportunities in Jammu and Kashmir"
[4] http://timesofindia.indiatimes.com/articleshow/70556996.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst
[5] "Dairy sector to boost employment in J&K"
[6] https://www.thehindubusinessline.com/economy/dairy-sector-to-boost-employment-in-jk/article28830751.ece
[7] "Steelbird Helmets to Setup New Manufacturing Plant in JK After Govt Scraps Article 370"
[8] "Union territory" [Online] Available: https://en.wikipedia.org/wiki/Union_territory
[9] "List of Indian states and union territories by GDP per capita"
[10] https://en.wikipedia.org/wiki/List_of_Indian_states_and_union_territories_by_GDP_per_capita

CHAPTER-6.6

Enhancing Efficiency of Communication in Cognitive Radio Network

Manoj Kumar Chaudhary[1], Ashutosh Bhatt[2]
[1]JB Institute of Technology, Dehradun,
[2]UOU, Haldwani

ABSTRACT: *Cognitive Radio Network (CRN) is a high potential technologyfor future networks since the spectrum resources are limited and it will use channels effectively, it refers that systems are aware of context and are capable of reconfiguring themselves based on the surrounding environments and their own properties with respect to spectrum, traffic load, congestion situation, network topology, and wireless channel propagation. The role of TCP is crucial in cognitive radio. The Primary User occupying or releasing a communication channel in CRN is to be handled properly when secondary user is using it. To handle this issue there should be a cognitive communication between TCP&MAC. This paper investigates this issue to overcome the TCP throughput decay in cognitive radio networks to enhance the efficiency of communication.*

Key Words- Cognitive Radio, TCP, MAC, Spectrum sensing, wireless communication

INTRODUCTION

In Cognitive Radio Networks the Primary User (PU) with Licensed Band and the Secondary User (SU) with Unlicensed Band plays key role in using bandwidth efficiently. As per the statistics of Federal Communication Commission (FCC) in [2], the utilization of the allocated spectrum in a geographical region vary from 15% to 85% .Cognitive Radio networks enhance utilization of bandwidth by allowing the SU to use idle bands. The SU can use the licensed band when primary user in not using it, SU employ access mechanisms to transmit data when the spectrum opportunity appears and these mechanisms are known as opportunistic spectrum access (OSA)[3],[4],[5]but PU is the highest priority user; it can influence SU traffic by both accessing and leaving its bandwidth. The PU in CRN differentiates it from the other entire wireless network. If possible, SU should avoid the primary user & stop transmitting data when PU wants to use the same bandwidth. In Cognitive Radio Networks the main functions are spectrum sensing, spectrum management, spectrum mobility, spectrum sharing [3]. The SU will make a channel sensing schedule to use the best available channel & manage it from interference of PU as per the access schedule allotted. The TCP throughput decay in wireless network is mainly due to environmental factors. The parameters of the MAC/PHY layer is communicated to the TCP layer to enhance the throughput. The transmission behavior of TCP plays the key role in throughput decay, rather than MAC, The MAC/PHY layer information is responsible for the SU to avoid the PU's interference. Therefore, the proposed solution investigates a cognitive communication between TCP & MAC that uses CR device information in cognitive radio networks to enhance the efficiency of communication.

In this paper, we study the issue to overcome the TCP throughput decay in cognitive radio networks and the proposed solutions for handling channel occupying or releasing by primary user when secondary user is using it. A packet loss due to the PU's interference can be sensed

by a CR device, because the PU's signal can be identified by its characteristics [3]. The SU can easily distinguish the PU's interference from other packet loss. The channel where primary user is not using very much indicates that Secondary User have high bandwidth capacity on an average whereas in opposite case Secondary User have low bandwidth capacity on an average. These cases impact TCP throughputs leading to some error estimate information. For instance, the RTT value is probably overestimated in the case of low bandwidth capacity with low PU activity.

This paper is organized as follows. In Section II we will discuss background and related work. Then, the proposed works are described in Section III. Performance evaluation of our proposal is done in Section IV and Section V concludes the paper and discusses the future work.

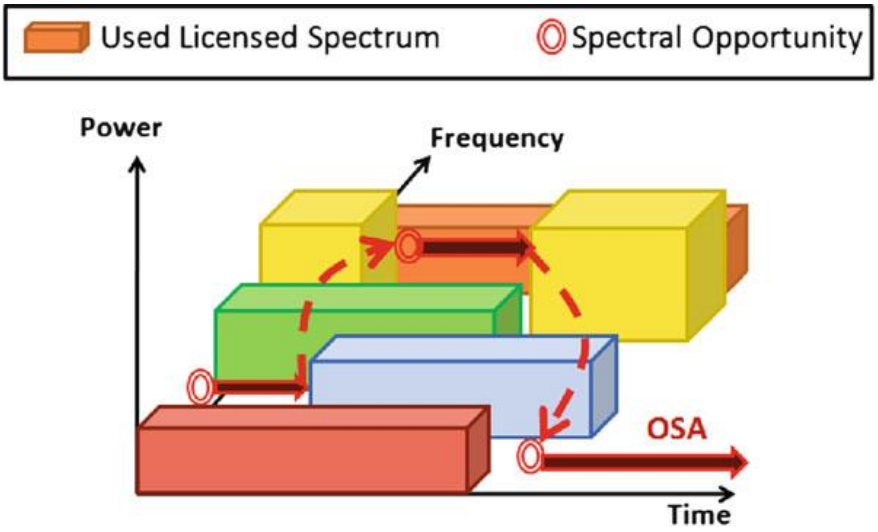


Fig1. Opportunistic Spectrum Access tracks

BACKGROUND & RELATED WORKS

Cognitive Radio: Cognitive radio (CR) [6] is a high potential technology for communications and networking, it refers to the solution to the problem of spectrum scarcity. In CR communication the radio spectrum is used in an opportunistic manner, while PU is not using it.CR enabled devices continuously monitor their radio environment in order to find so-called spectrum holes, that is, channels which are unused at a particular time and location. Such bands are used for communication between CR devices. Since CR users are secondary users, they have also to constantly monitor the used band to detect any activity by primary users as soon as primary users appear, CR users have to take measures to avoid interfering with them, like e.g. moving to a different, free frequency bandor reducing their transmission power.It is therefore of the utmost importance to understand the performance of CR systems, and especially the impact they may have on the performance of users applications and users experience. Cognitive radio can be regarded as a software-defined radio (SDR), where a cognition cycle allows for wireless terminals to be known of their radio environment and to adapt to it accordingly [7].

Since its introduction by Mitola [7], the concept of cognitive radio has been the subject of much research effort. Many solutions have been proposed in the related field to address TCP issues on cognitive radio network. A cognitive TCP for example, [12] suggests a TCP solution by adapting MAC/PHY parameters to improve throughput. The codec & modulation in the physical layer, and frame size in the MAC layer can change dynamically to maximize TCP throughput. TCPCRAHN [13] is a window-based, TCP-like spectrum-aware transport layer protocol for CR ad-hoc networks. The main idea of TCP CRAHN is to distinguishes between different spectrum specific conditions like (a) spectrum sensing and switching, (b) a PU sudden appearance, (c) SU's movement, and then to take state-dependent recovery actions. In the other words, [12], [13] focus on the cases of lower layers' influence on TCP. The TCP throughput decay is due to variance bandwidth in a CR environment. A throughput decay problem, which is due to improper congestion window decay while TCP flow passes the CR link, is studied. We consider the congestion window decay as a slight-level congestive loss to TCP [14][15][16].

Proposed Work: As shown in Fig2. When primary user wants to access a channel when secondary user is using it, there will be a case of collision, and the secondary user should leave the occupied channel and give its access to primary user. Due to this interference secondary user may loss packets. When primary user leaves this occupied channel, Secondary user congestion event will occur which will increase its bandwidth capacity. Due to these activities RTT in TCP will vary and bandwidth capacity of secondary user will change. To overcome this problem, we use CR-MAC protocol [10]. This MAC protocol is based on the following characteristics: 1) Secondary User has a fixed MAC super-frame size & it will scan all channels and decides which channel to access in the beginning of each super frame. 2) N orthogonal channels for the Primary User and Secondary user to use without any interference with each other.

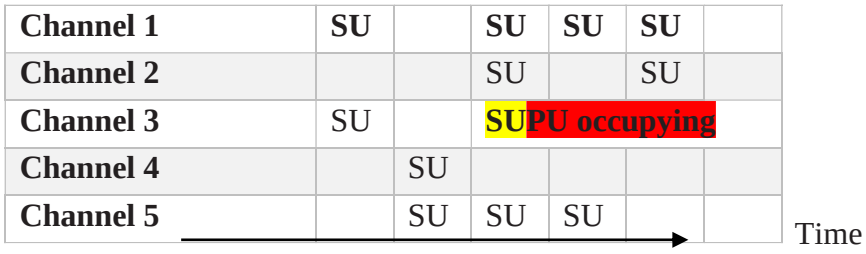


Fig2. PU Occupying Channel in MAC Super Frame

Secondary user can access all the channels simultaneously. The total bandwidth capacity is the aggregate of the entire channel it will use. 3) Secondary user will vacate all the channels in use whenever the Primary user accesses it. 4) Channel must contain at least one Primary User transmitter-receiver pair. 5) The MAClayer willprovide historical channel utilization information of the Primary User and actual channel availability. 6) The MAC layer can differentiate between noise or another Secondary user signal& Primary user signal.

The CR-MAC characteristics (5) figure out the historical channel utilization of a PU and current channel availability. The PU's historical channel utilization indicates long-term trends

of probability that a PU will interfere with a SU. This information also helps a SU to identify better channels (which mean less chance to be interrupted) to access. Next is current channel availability, a SU's maximum bandwidth capacity on a CR link can be derived from channel availability. Bandwidth capacity is a less time information for a MAC-super-frame. This information does not indicate actual value of the remaining availability of a CR link. Using the information from these cases we will investigate when TCP throughput decay occur. The long-term history of the link will provide general cases of the link. For instance, when channel with less PU influence indicates that SUs have high bandwidth capacity on average. However, to a CRlink, bandwidth capacity may be temporarily low for unstable real-time channel availability. Short-term information probably shows opposing trends to long-term information in some rare cases. These rare cases impact TCP throughputs leading to some error estimate information. For instance, the RTT value is probably overestimated in the case of low bandwidth capacity with low PU activity.

Following information is required for cognitive communication between TCP & MAC:

- History of channel accessed by Primary user, describing that statistics when a Primary User will take access when Secondary user is using that channel.
- Available Channels, which helps secondary user to get the bandwidth capacity to reduce packet loss.
- To find out when TCP throughput decay occurs from the information provided by Cognitive Radio Devices.

When Secondary user access a channel in each MAC super frame, the packets lost due to Primary user interference loss event can be retransmitted in the beginning of the next super-frame rather than waiting for other retransmission mechanisms. If a PU interfere SU, the PU-interference handler [1] sends all packets in the congestion window again at the beginning of the next MAC super-frame. A worst-case may occur if the TCP's packets are retransmitted by the back-off mechanism: if a PU interfere SU exactly when that TCPbacks-off, TCP clients may starve even if a PU's traffic load is light. The starvation, which causes throughput decline, is more serious when the MAC super-frame is longer. On the other hand, if the MAC super-frame is short, the collided packets are possibly recovered by MAC retransmission. By forcing the collided packets to be retransmitted at the beginning of the MAC super-frame, the starvation cases can be relaxed. However, forcing the packets to retransmit causes duplicate packets. To avoid decreasing the congestion window, ACKs of retransmitted packets are not counted into duplicate ACKs.

A faster-recovery mechanism [1] is implemented when a mild-congestion situation occurs; the TCP stores parameters of the congestion window (size, thresholds. . . etc.). After a period, p, the TCP client tries to restore these parameters. Fig. 3 illustrates the idea of the fast recovery mechanism. Two problems of implementing the faster-recovery mechanism include: when to execute (to differentiate a condition of low bandwidth capacity with low PU influence) and when to restore parameters (to find out p). Concerning, the first case, we must

differentiate the cases of “high bandwidth availability from low bandwidth availability in a low PU influence. A bandwidth availability estimator of a CR link is introduced by aggregating multiple ON-OFF traffic models.

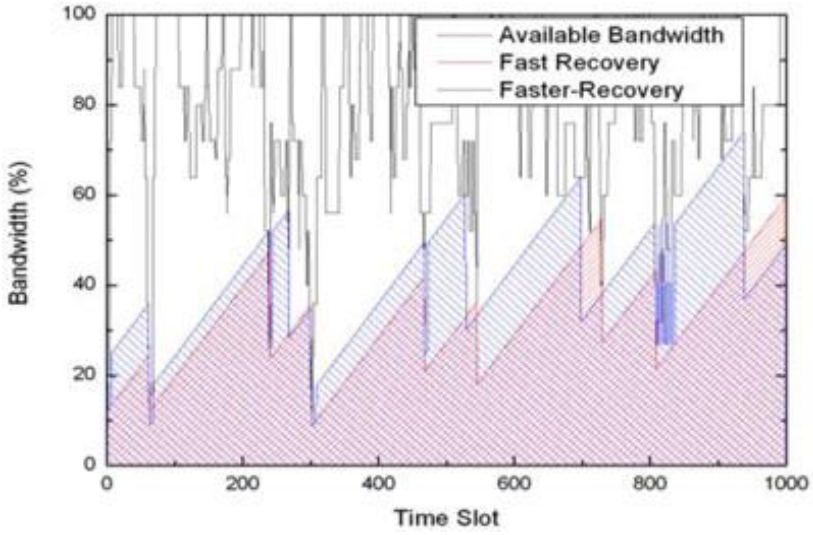


Fig3. Faster-recovery mechanism [1].

To distinguish between the high and low bandwidth availability of a particular PU activity case, a threshold that implies situations of rising/falling bandwidth availability is used. That is provided a certain PU activity ratio, the bandwidth capacity value of a congestion event is “high” or “low,” and it can be driven from this threshold.

Parameter	Value
Bandwidth per channel	100 Kbps, 1Mbps
Total Channel	10
PU Influence	1%,75%
Sensing Interval	1,2 seconds

Table 1 Parameters of Simulation

RESULTS

Fig4. Show performance level to overcome the TCP throughput decay in cognitive radio networks for handling channel occupying or releasing by primary user when secondary user is using it. The study is done using NS-2. 10 channels are used in the CR link. An SU can use N channels simultaneously from 1 to 10. Channel has a fixed bandwidth during simulation. An SU senses a channel in every 2 second, IEEE 802.22 standard [14], and this interval equals the length of the MAC super-frame. Simulation, parameters are arranged inTable1. Improvement in TCP throughput slightly decreases with increased channel bandwidth. The

reason for that is the MAC can resend the collided packets faster if the channel bandwidth is higher, which indicates that the TCP suffers a less packet timeout event. As a result, Fig. 5 the TCP has less packet loss events due to PUs' influence.

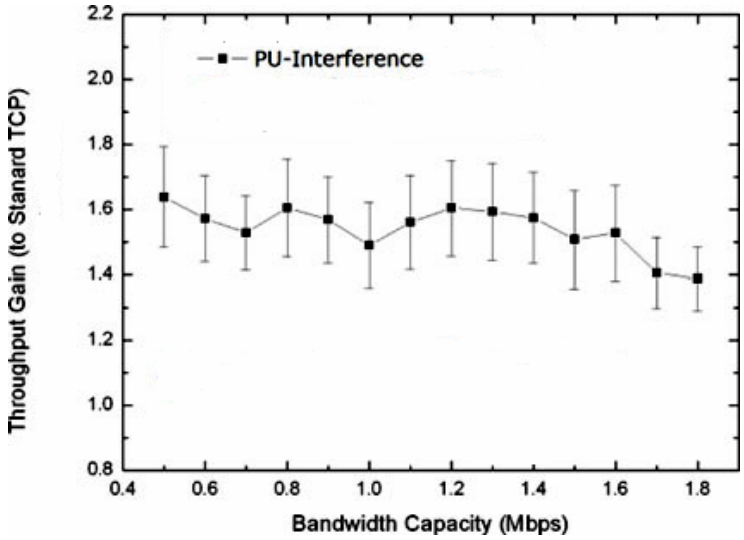


Fig4. Performance of PU in different Bandwidth Capacity.

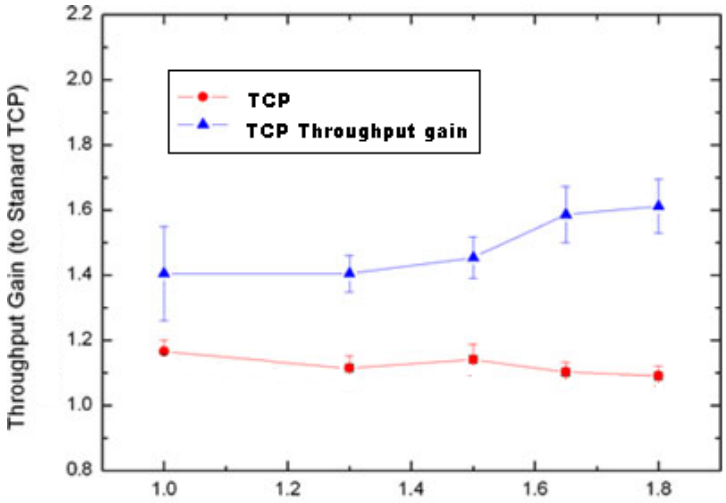


Fig5. Performance of TCP in sensing interval after throughput gain in Cognitive Radio Networks.

CONCLUSION

In this paper, we investigate the TCP throughput decay problem arise in CRN due to PU & SU. We proposed a cognitive communication between TCP & MAC to enhance the performance of TCP over cognitive radio networks. Simulation results in Fig5.show that the proposed solution significantly improves TCP throughput over CRN in different situations. The performance of the proposed mechanism was evaluated, and it showed significant improvement in terms of link utilization efficiency as compared to standard TCP. In future we would like to develop our simulator with more details related to micro mobility and new cognitive radio parameters.

REFERENCES

[1] Cheng Yu-Chun, Cheng-Fu Chou, Eric Hsiaokuang Wu, and Gen-Huey Chen "A Cognitive TCP Design for a Cognitive Radio Network with an Unstable-Bandwidth Link" IEEE TRANSACTIONS ON COMPUTERS, VOL. 64, NO. 10, OCTOBER 2015

[2] "Spectrum policy task force," Federal Commun. Comm., Washington,DC, USA, Rep. ET Docket., Nov. 2002.

[3] I. F. Akyildiz, W.-Y. Lee, M. C. Vuran, and S. Mohanty, "NeXt generation/dynamic spectrum access/cognitive radio wireless networks: A survey," Comput. Netw., vol. 50, pp. 2127–2159, 2006.

[4] J. D. Poston and W. D. Horne, "Discontiguous OFDM considerations for dynamic spectrum access in idle TV channels," inProc. First IEEE Int. Symp. New Frontiers Dynamic Spectrum Access Netw.,

[5] J. Juncheng, Z. Qian, and S. Xuemin, "HC-MAC: A hardwareconstrained cognitive MAC for efficient spectrum management," IEEE J. Select. Areas Commun., vol. 26, no. 1, pp. 106–117, Jan. 2008.

[6] S. Haykin, "Cognitive radio: Brain-empowered wireless communications," IEEE J. Select. Areas Commun., vol. 23, no. 2, pp. 201–220,Feb. 2005.

[7] J. Mitola III and G.Q. Maguire Jr. "Cognitive radio: making software radios more personal." IEEE Personal Communications, 6(4):13-18,August 1999.

[8] Y. R. KondaReddy and P. Agrawal."Effect of Dynamic Spectrum Accesson Transport Control Protocol Performance." IEEE GLOBECOM 2009,Nov. 30 - Dec. 4 2009.

[9] "IEEE P802.11 Task Group af - Wireless LAN in the TV White Space."

[10] T. Issariyakul, L. S. Pillutla, and V. Krishnamurthy, "Tuning radio resource in an overlay cognitive radio network for TCP: Greed isn't good," IEEE Commun. Mag., vol. 47, no. 7, pp. 57–63, Jul. 2009.

[11] C. Yu-Chun, E. H. Wu, and C. Gen-Huey, "A new wireless TCP issue in cognitive radio networks," in Proc. 1st Int. Conf. Netw.Comput., 2010, pp. 49–54.

[12] C. Luo, F. R. Yu, H. Ji, and V. C. M. Leung, "Cross-layer design for TCP performance improvement in cognitive radio networks," IEEE Trans. Veh. Technol., vol. 59, no. 5, pp. 2485–2495, Jun. 2010.

[13] K. R. Chowdhury, M. D. Felice, and I. F. Akyildiz, "TCP CRAHN: A transport control protocol for cognitive radio ad hoc networks,"

[14] IEEE Trans. Mobile Comput., vol. 12, no. 4, pp. 790–803, Apr. 2013.

[15] C. Stevenson, G. Chouinard, L. Zhongding, H. Wendong, S. Shellhammer, and W. Caldwell, "IEEE 802.22: The first cognitive radio wireless regional area network standard," IEEE Commun. Mag., vol. 47, no. 1, pp. 130–138, Jan. 2009.

[16] Reem E. Mohamed1, Walid R. Ghanem2, 3 and Mohamed A. Mohamed1"TECEAP: Two-tier Era-based Clustering Energy-efficient Adaptive and ProactiveRouting Protocol for Wireless Sensor Networks" in NRSC 2018.

[17] "Performance Analysis of Deep Learning Based Routing Protocol for an Efficient Data Transmission in 5G WSN Communication", Ashish Bagwari, Greeshma Arya, and D.S. Chauhan "IEEE Access", Vol. 10, No. 2022, pp 9340-9356, January 2022, Print ISSN: 2169-3536, Online ISSN: 2169-3536.

INTEGRATED SOLUTIONS: MANAGEMENT

CHAPTER-7.1

A Model for Effectively Creating New Products

Harish Prasad Sati, Dr. Anuj Gupta
Management Department, JB Institute of Technology, Dehradun
harishprasadsati123@gmail.com

ABSTRACT: *Organizing and managing the development of new products has been perceived as a difficult task in both academic and industrial settings for many years. Unfortunately, the aspect of sustainability has often been overlooked in this process, despite the opportunity to incorporate sustainable characteristics throughout the product's life cycle. The aim of this paper is to establish a connection between sustainability and new product development by presenting a conceptual framework that highlights the interdependencies between these two concepts, adopting a life-cycle and product-centric perspective. To date, no such connection between sustainable new product development and the life cycle of the product has been extensively explored. This paper seeks to elucidate this relationship, bridging the topics of new product development and sustainability, ultimately promoting a life-cycle approach that supports the development of sustainable new products. The proposed conceptual framework emphasizes the importance of involving life-cycle management and product life-cycle management to achieve sustainable new product development. By adopting a product-focused product life-cycle management approach, it provides the necessary structure for collaborative and sustainable new product development, incorporating cross-departmental and cross-company processes, data, and individuals. Collaboration plays a crucial role in integrating life-cycle-based concepts to achieve sustainable new product development. This paper contributes in two ways: firstly, it presents a fresh conceptual framework for sustainable new product development through the application of product life-cycle management, thereby extending existing research on environmentally friendly new product development; secondly, it offers an approach focused on life*-cycle management to facilitate collaboration by reducing complexity, harmonizing processes, and leveraging technology.

Keywords: New product development, critical success factors, metrics, tools and techniques

INTRODUCTION

The new product development (NPD) literature emphasizes the importance of introducing new products on the market for continuing business success. Its contribution to the growth of the companies, its influence on profit performance,and its role as a key factor in business planning have been well documented (Booz, Allen & Hamilton, 1982; Crawford, 1987; Urban & Hauser, 1993; Cooper, 2001; Ulrich & Eppinger, 2011). New products are responsible for employment, economic growth, technological progress, and high standards of living. Therefore, the study of NPD and the processes through which they emerge is important.

In the last few decades, the number of new product introductions increased dramatically as the industry became more aware of the importance of new products to business. Correspondingly, managing the NPD process has become a challenge for firms as it requires extensive financial and human resources and is timesensitive. The harsh realities are that the majority of new products never make it to market and those that do face a failure rate somewhere in order of 25 to 45percent (Crawford, 1987; Cooper, 2001). For every seven

new product ideas, about four enter development, one and a half are launched, and only one succeeds (Booz, Allen & Hamilton, 1982). Despite the extensive research on how to achieve success in NPD, firms continue to deliver products that fail and therefore NPD ranks among the riskiest and most confusing tasks for most companies. As the number of dollars invested in NPD goes up, the pressure to maximize the return on those investments also goes up. It becomes worse as an estimated 46 percent of resources allocated to NPD are spent on products that are canceled or fail to yield an adequate financialreturn.

In this paper, we propose a framework that identifies the critical success factors (CSF) for each phase in the NPD process, metrics to measure them, and techniques that can be used to evaluate each metric. Our study is based on an extensive review of the NPD literature. The paper is presented as follows. In the next section, we discuss the NPD process, followed by a discussion of critical success factors and metrics. Our framework is then described in detail, and we conclude with a discussion of our work.

New product development: The NPD process consists of the activities carried out by firms when developing and launching new products. A new product that is introduced on the market evolves over a sequence of stages, beginning with an initial product concept or idea that is evaluated, developed, tested and launched on the market (Booz, Allen & Hamilton, 1982). This sequence of activities can also be viewed as a series of information gathering and evaluation stages. In effect, as the new product evolves, management becomes increasingly more knowledgeable (or less uncertain) about the product and can assess and reassess its initial decision to undertake development or launch. Following this process of information gathering and evaluation can lead to improved new product decisions on the part of firms by limiting the level of risk and minimizing the resources committed to products that eventually fail. The NPD process differs from industry to industry and from firm to firm. Indeed it should be adapted to each firm in order to meet specific company resources and needs (Booz, Allen & Hamilton, 1982).

Many researchers have tried to develop a model that captures the relevant stagesof the NPD process (Ulrich & Eppinger, 2011; Wind, 2001; Cooper, 2001; Crawford, 1987; Scheuing, 1974). A number of detailed NPD models have been developed over the years, the best known of which is the Booz, Allen and Hamilton (1982) model, shown if Figure 1, also known as the BAH model, which underlies most other NPD systems that have been put forward. This widely recognized model appears to encompass all of the basic stages of models found in the literature. It is based on extensive surveys, in depth interviews, and case studies and, as such, appears to be a fairly good representation of prevailing practices in industry.

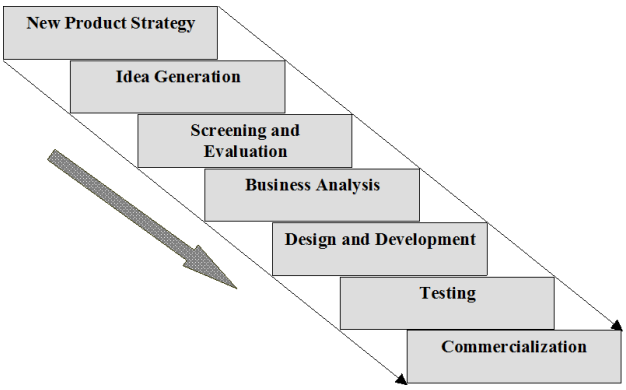


Figure 1. Stages of New Product Development (NPD) (Booz, Allen & Hamilton, 1982)

The stages of the model are as follows:

- **New Product Strategy:** Links the NPD process to company objectives and provides focus for idea/concept generation and guidelines for establishing screening criteria.
- **Idea generation:** Searches for product ideas that meet company objectives.
- **Screening:** Comprises of an initial analysis to determine which ideas are pertinent and merit more detailed study.
- **Business Analysis:** Further evaluates the ideas on the basis of quantitative factors, such as profits, Return-on-investment (ROI), and sales volume.
- **Development:** Turns an idea on paper into a product that is demonstrable and producible.
- **Testing:** Conducts commercial experiments necessary to verify earlier business judgments.
- **Commercialization:** Launches products.

Booz, Allen and Hamilton (1982) found that companies that have successfully launched new products are more likely to have some kind of formal NPD processand that they generally pass through all of the above stages. Our framework is based on the BAH model, however, we exclude the commercialization stage; while this stage represents an important area of concern, our study deals with the pre- commercialization stages of the NPD process.

Critical success factors: Over the last two decades, several studies have examined the determinants of NPD success and identified many factors that distinguish successful products from unsuccessful ones. Factors that are necessary and guarantee commercial success are termed as critical success factors (CSF): it is imperative to reflect on how one can benefit from each and how one can translate each into an operational aspect of the NPD process. Daniel (1961) and Rockart (1979) proposed that organizations need to identify factors that are critical to the success of that organization, andthey suggested that the failure to achieve goals associated with those factors would result in organizational failure. In fact, it is even suggested that NPD itself is a CSF for many organizations. Given that this is now a well-known fact, the idea is to determine what factors in NPD are essential for success, and how to

measure the extent of this success. The challenge is to design a process for successful product innovation - a process whereby new product projects can move quickly and effectively from the idea stage to a successful launch and beyond.

Metrics: A metric tracks performance and allows a firm to measure the impact of process improvement over time. Metrics can play an important role in helping companies to enhance their NPD efforts and are important for at least three reasons. First, metrics document the value of NPD and are used to justify investments in this fundamental, long term, and risky venture. Second, good metrics enable Chief Executive Officers and Chief Technical Officers to evaluate people, objectives, programs, and projects in order to allocate resources effectively. Third, metrics affect behavior. When scientists, engineers, managers, and other NPD employees are evaluated on specific metrics, they often make decisions, take actions, and otherwise alter their behavior in order to improve the metrics. The right metrics align employees' goals with those of the corporation; wrong metrics are counterproductive and lead to narrow, short-term, risk-avoiding decisions andactions.

Any metric that might be applied to NPD will often focus on one function or another or on the entire NPD process. But no one function is the sole contributor to the process that produces new products. A metric for the productivity of the R&D organization, for example, may show constant improvement. In spite of this improvement, however, there may be no improvement in the rate at which new products reach the market (Beliveau et al., 2002). What is important to measure is the effectiveness of the stages of NPD process in an interdependent fashion. A lack of useful metrics is undoubtedly one reason that the success rate of NPD has not improved appreciably over the past 40 years Crawford (1979, 1992). If companies had reliable metrics to gauge their performance, then specific problem areas could be addressed and managers might see the same improvement in their NPD efforts that they come to expect from their quantifiable total quality management programs (Lynn & Reilly, 2000).

Critical success factors and metrics for stages of the NPD process: In what follows, each stage of the NPD process and its respective CSFs, metrics, and tools and techniques for measuring progress are explained in detail.

New Product Strategy: Prior to commencing an NPD project, companies must set objectives and devise a clear new product strategy (NPS) to meet them (Wind, 1982). The purpose of this stage is to provide guidance for the new product effort. It identifies the strategic business requirements that the new product should comply with, and these are derived from the corporate objectives and strategy of the firm as a whole. These business requirements assign roles to be played by the new products, which in turn are influenced by the needs of the industry (Booz, Allen & Hamilton, 1982).

CSFs for NPS: A firms' strategy should provide a clear understanding of the goals or objectives for the company's new product program, and should indicate the return-on-investment (ROI) expected such that the contribution of new products to corporate goals is well-understood. Furthermore, clearly defined arenas, i.e., specified areas of strategic focus,

such as products, markets, or technologies, are needed to give direction to the firm's total new product program.

The problem at this stage is not only one of developing a clear strategy but also its implementation, i.e., translating the strategy into terms that everyone understands to bring focus to day-to-day actions, and communicating the strategy with other members in the organization. Prior research suggests that companies that recognize the importance of interventional coordination and effectively sharing an NPS across departments will have more successful new products (Cooper, 1999). The role of new products in achieving company goals was clearly communicated to all in such firms. Thus, once a clear NPS is defined, the related confounding problem is communicating clearly the needs, requirements, resources, and plans for a new product effort - in essence, internalizing the strategy. This communication must take place in multiple forms; however, a well-documented plan and specification must serve as the foundation. In summary, the establishment and communication of a clear plan and a strategy for an NPD project is a key requisite for success. Businesses that have a well-articulated NPS fare much better thanthose lacking in this aspect and they have 32 percent higher NPD success rates, meet sales objectives 42 percent more often, and meet profits objectives 39 percent better (Cooper & Kleinschmidt, 1995).

Metrics for NPS: The return-on-investment (ROI) compares the company's yearly income with the investment in the asset. While the ROI is not too challenging, management should understand how the ROI benchmarks have been calculate so that relevant comparisons can be made for the project under evaluation. A company's ROI proves to be useful in setting the new product goals. This metric will help to determine if the cost to develop a new product exceeds the resulting benefit, or if the payback affects the corporate bottom line. The aim here is to compare the return expected to be received from the project with some pre-established requirement. This long-term metric set by the corporate objectives should be linkedwith the NPS.

Tools and techniques for NPS: The Balanced Scorecard (BSC) provides the instrument the firm needs to navigate to future competitive success (Kaplan & Norton, 1996). BSC translates an organization's strategy into a comprehensive set of performance measures that provides the framework for a strategic measurement and management system. Thescorecard measures organizational performance drivers across four perspectives which provide its framework: financial, customers, internal business processes, and learning and growth. The objectives and the measures of the BSC are the collection of financial and non-financial performance measures; they are derived from a top- down process driven by the strategy of the business unit. The measures are balanced between the outcome measures - the results from past efforts - and the measures that drive future performance. The scorecard is balanced between objectives, easily quantified outcome measures and subjective performance drivers of the outcome measures.

Organizations should use the scorecard as a strategic management system, to manage their strategy over the long run and use it for the measurement focus of the scorecard to accomplish critical management processes, including communicating and linking strategic objectives and measures.

The BSC strategic objectives and measures are communicated throughout an organization via company newsletters, bulletin boards, videos, and even electronically through groupware and networked personal computers. The communication serves to signal to all employees of the critical objectives that must be accomplished if an organization's strategy is to succeed. Once all employees understand high-level objectives and measures, they can establish local objectives that support the business unit's global strategy.

The organizational communication and education program should not only be comprehensive but also periodic. Multiple communication tools can be used to launch the BSC program: executive announcement, videos, meetings, brochures and newsletters. This initial announcement should then be followed continually, by reporting scorecard and outcomes on bulletin boards, newsletters, groupware, and electronic networks. The design of such a program should begin by answering fundamental questions:

- What are the objectives of the communication strategy?
- Who are the target audiences?
- What is the key message for each audience?
- What are the appropriate media for each audience?
- What is the time frame for each stage of the communication strategy?
- How will top management know that the communication has been received?

The BSC links financial objectives to corporate strategy. The financial objectives serve as the focus for the objectives and measures in all the other scorecard perspectives. Every measure should culminate in improving financial performance. The scorecard starts with long-run financial objectives, and then links them to the sequence of actions that must be taken with financial processes, customers, internal processes, and finally employees and systems to deliver the desired long run economic performance. Many corporations, however, use identical financial objectives for all of their divisions and business units. This uniform approach is certainly feasible, consistent, and fair since all business unit managers will be evaluated by the same metric, but different business units may follow quite different strategies.

Idea Generation: After setting a well-defined NPS for NPD, the idea generation stage begins, where the search for product ideas is made to meet company objectives. The idea generation concerns the birth, development, and maturation of a concrete idea. After defining the markets and segments based on the NPS it wishes to target, the firm must advance and nurture ideas wherever they occur to take advantage of the identified opportunities. As per

the study done by Booz, Allen and Hamilton (1982), a firm has to generate at least seven ideas to generate one successful. Griffin (1997) says that an average of 100 ideas must be generated in order to yield 15.2 successes.

The main purpose of this stage is to create a number of different ideas from which the firm can select the most feasible and promising one(s). A greater likelihood of achieving success depends in part on the number of ideas generated. Firms that areeffective at idea generation are those that do not focus solely on the first source to generate ideas, i.e. ideas that are originated from inside the firm, but that concentrate on all potential idea sources (Crawford, 1997). There is a multitude of sources as well as many different methods to generate ideas. The firm can derive new ideas from internal sources (i.e., employees, managers), external sources (i.e., customers, competitors, distributors, and suppliers), and from implementing formalresearch and development. Brainstorming, morphological, analysis and gap analysisare most commonly employed methods for generating ideas (Crawford, 1997). Customers can be an especially good place to start searching for new product ideas. The relatively high rate of success for product ideas originated from marketing personnel and customers (Souder, 1987).

CSF for Idea Generation: Customer focused idea generation is a CSF for this stage as per studies done by many researchers that show that a thorough understanding of customer's needsand wants is vital for new product success (Cooper, 1993; Crawford, 1987). Successful businesses and teams that drive winning new products have a dedicationtowards the voice of the customer. A strong customer involvement is necessary right from the idea generation stage. According to Souder's (1987) review of causes of NPD success and failure, he concluded that internally generated ideas had lower success rates then externally generated ideas. A relatively high rate of success is achieved for project ideas that originated from marketing and customers as compared to ideas originating from R&D, suppliers, and management.

Metrics for Idea Generation: Metrics to track idea generation and enrichment include: number of ideas generated from the customer, number of ideas retrieved and enhanced from an idea portfolio, number of ideas generated over a period of time, and the value of ideas in idea bank. Among all of these metrics, the number of ideas generated from the customer is the most associated with the CSF of the idea generation stage. Firms must devote more resources to customer based idea generation activities, such as focus groups with customers; detailed, one-on-one interviews with customers; customer site visits, especially by technical people; the active solicitation of ideas from customers by the sales force; and the development of a relationship with lead users (Cooper, 1999).

Tools and techniques for Idea Generation: Understanding customer and market needs is a consistent theme for successful product development in studies by Song and Parry (1996) and Cooper (1999). There are many creativity and brainstorming techniques for enriching the idea stream. Effective methods for enriching the customer-based idea stream utilize leaduser methodology and ethnographic approaches.

The lead user methodology takes a different approach as compared to traditional approaches in which ideas are generated based on customer input and usually collects information on new product needs from a random or typical set of customers. The lead user process collects information about both needs and solutions from the leading edges of the target market and from markets facing similar problems in a more extreme form. The rich body of knowledge collected during this process continues to be useful during the remaining steps of product development and marketing (Lilien et al., 2002).

An ethnographic approach is a descriptive, qualitative market research methodology for studying the customer in relation to his or her environment (Cooper & Edgett, 2008). Researchers spend time in the field observing customers and their environment to acquire a deep understanding of customer's lifestyles or cultures as a basis for better understanding their needs and problems. In this approach, observation, interviews and documentation are done for traces that people leave as they go about their everyday lives. Since it allows the use of multiple converging perspectives - what people say, do, and use - it will always reveal more and provide greater insight. This deeper level of understanding is derived from customer to generate customer-based ideas.

Screening and Business Analysis: While the screening and business analysis are proposed as two different stages in the BAH model, we consider the two stages as one for simplicity of the proposed framework. In the screening stage, initial analysis is done based on the NPS, resources and competition, while in the business analysis stage, ideas are evaluated using quantitative performance criteria. After gathering enough new product ideas through various sources from the idea generation stage, which ideas to pursue will be selected based on the business value they bring. Making a good selection is critical to the future health and success of the business. The point is that product development costs rise substantially with each successive stage in the NPD process (Booz, Allen & Hamilton 1982). The ideas that have been classified as "Go" ideas must be screened further using criteria set up by top management (Cooper & de Brentani, 1984; de Brentani, 1986). These ideas must be described on a standard form that can be accessed by a new product committee. The committee then assesses each idea against a set of criteria, which verify the attractiveness and visibility of the idea as well as its fit with the company's strategy, objectives and resources. The ultimate result from screening and evaluation is a ranking of NPD proposals, such that the resources can be allocated to the projects that seem most promising (Crawford, 1997; Wind, 1982).

After screening, the business analysis is the detailed investigation stage that clearly defines the product and verifies the attractiveness of the project prior to heavy spending. According to Cooper's NewProd studies of new product, it was shown that weakness in the upfront activities seriously compromises the project performance. Inadequate market analysis and a lack of market research, moving directly from an idea into a full-fledged development effort, and failure to spend time and money on the up-front steps, are familiar themes in product failures. The quality of execution of the predevelopment steps is closely tied to the product's

financial performance (Cooper, 1980).

In every successive stage of the NPD process, as estimates become more refined and accurate, companies should continue conducting financial evaluation throughout the NPD process, but at this stage it is critical. A review of a costs, potential sales and profit projections of the new product are undertaken in order to determine whether these factors satisfy the company's objectives or not. If a result from this stage shows that the product meets the objectives, then the new product concept can move to the development stage. According to Griffin (1997) among the firms taking part in study, 75.6% developed formal financial objectives against which performance was measured. The final component of the business analysis stage is the action plan. A detailed plan of action is created for the next stage and tentative plans are developed for all subsequent stages. This critical stage opens the door to a significant commitment of resources and to a full-fledged development program based on financial analysis which forms the base for the CSF and its metrics proposed for this stage.

CSF for Screening and Business Analysis: Up-front homework is a CSF for the screening and business analysis stage as too many new product projects move from the idea stage right into development with little or no early preparation (Rosenau et al., 1996). The results of this approach are usually disastrous. Up-front homework includes activities such as financial analysis, undertaking thorough market and competitive analyses, research on the customer needs and wants, concept testing, and technical and operations feasibility assessments. Solid pre-development work drives up new product success rates significantly and is strongly correlated to financial performance. All of these activities lead to solid business analysis prior to beginning serious development work. Firms devote on average only seven percent of a project's funding and 16 percent of the person-days to these critical up-front homework activities, which is not enough to make a successful product according to the NewProd (1999) study. The conclusion is that more time and resources must be devoted to the activities that precede the design and development of the product.

As per a study done by Cooper et al. (2000), the most dominant method used by 40.4% of businesses for performance results is a financial approach, followed by strategic approaches and scoring models. Using financial methods, profitability, return, payback or economic value of the project are determined and projects are judged and rank-ordered on these criterion.

Metrics for Screening and Business Analysis: Financial or economic models treat project evaluation much like a conventional investment decision. The expected commercial value (ECV), net present value (NPV), internal rate of return (IRR), and the profitability index (PI), are metrics thatare proposed as being most useful for measuring the success of the screening and business analysis stage. These metrics should be used to rate, rank order, and ultimately select projects. All metrics have their own advantages and disadvantages. For example, the NPV method ignores probabilities and risk; it assumes that financial projections are accurate and financial goals are important. The ECV depends on extensive financial and

other quantitative data. These metrics together give clearer details about the project's financial performance to help selectthe best project from the group.

Tools and techniques for Screening and Business Analysis: The financial methods of evaluation for the proposed metrics and how they measure the financial performance of each project are explained below.

The Expected Commercial Value (ECV) method seeks to maximize the value or commercial worth of the project, subject to certain budget constraints, and introduces the notion of risks and probabilities. The ECV method determines the value or commercial worth of each project to the corporation. The calculation of the ECV is based on a decision tree analysis and considers the future stream ofearnings from the project, the probabilities of both commercial success and technical success, and both commercialization costs and development costs. Therefore, the ECV measures the value of the project in terms of its expected financial returns from the perspective of the company's overall commercial strategic objectives. In order to arrive at a prioritized list of projects, the ECV of each projectis determined projects are rank ordered accordingly.

The net present value (NPV) criterion for evaluating proposed capital investments involves summing the present values of cash outflows required to support an investment with the present value of the cash inflows resulting from operations of the project. The inflows and outflows are discounted to present value using the firm's required rate of return for the project. If the NPV is positive, it means the project is expected to yield a return in excess of the required rate; if the NPV is zero, the yield is expected to exactly equal the required rate; if the NPV is negative,the yield is expected to be less than the required rate. Hence, only those projects that have a positive or zero NPV meet the criterion for acceptance.

The internal rate of return (IRR) is that rate which exactly equates the presentvalue of the expected after-tax cash inflows with the present value of the after-tax cash outflows. Once the IRR of a project has been determined, it is a simple matter to compare it with the required rate of return to decide whether or not the projectis acceptable. If the IRR equals or exceeds the required rate, the proje acceptable. Ranking the projects is also a simple matter. Projects are ranked according to the IRRs: the project with the highest IRR is ranked first and so on.

The profitability index (PI) is the ratio of the present value of the after-tax cash inflows to the outflows. A ratio of one or greater indicates that the project in question has an expected yield equal to or greater than the discount rate. The profitability index is a measure of a project's profitability per dollar of investment.As a result, it is used to rank projects of varying costs and expected economic lives in order of their profitability. Projects are rank-ordered according to this productivity index in order to arrive at the preferred portfolio, with projects at the bottom of the list placed on hold. In order to ensure that project ideas are carefully screened, and that the business analysis is carefully carried out, these metrics are certain to help select projects so as to maximize the sum of the values of all active projects in the firm's

pipeline in terms of business objectives.

Development: Once the results of the business case of the new product conform to company objectives, the new product team can move on to the development stage, which is made up of activities that range from prototype development to volume ramp up and test marketing. The interaction between the program and project manager isno longer one of selling or buying the concept, but rather one of bringing the product to market on time, within budget, and to the required specifications.

On average, one third of total NPD expenditures are committed during this stage with 40 percent of total NPD time (Cooper, 1999). In the development stage, business case plans are translated into concrete deliverables. What is critical for success at this stage to move through development to launch as quickly as possibleand to ensure that the product prototype or final design does indeed meet customer requirements, which requires seeking customer input and feedback throughout the entire development stage. It is important to gain competitive advantage and to enjoy the product's revenues as soon as possible and it also minimizes the impact of a changing environment. Thus, as the product proceeds from one step of the development stage to the next, the new product team should reassess the market, position, product, and technology in order to increase chances of delivering a successful product (Cooper, 1993; Urban & Hauser, 1993). Marketing and R&D functions in particular should collaborate because, while marketing can express the needs of customers, R&D has the capacity to turn a product concept into an actual physical entity. Therefore, they should work together to ensure the product meets customer requirements. Cross-functional teams are widely used in companies to help in identifying and solving problems efficiently by coordination of resources and ideas. Customer input and feedback is a critical activity throughout development, both to ensure that the product is right andto speed development toward a correctly defined target.

CSFs for Development: Development of new products often takes years, and much that is unexpected can occur during this time frame. The market may change partway through development, making the original estimates of market size and product acceptance invalid. Customer requirements may shift, rendering the original set of product specifications obsolete. Competitors may introduce similar products in the meantime, creating a less receptive market environment. These and other external changes mean the original product definition and justification are no longer valid.

Reducing development time is a vital competitive weapon and yields competitive advantage; it means that there is less likelihood that the market or competitive situation has changed by time the product reaches the market and it means a quicker realization of profits Cooper (1993, 1999, 2001). Companies that develop products quickly gain many advantages over their competitors: premium prices, valuable market information, leadership reputation with consumers, lowerdevelopment costs, and accelerated learning (Cooper, 2001). Therefore, the goal of reducing the development time is critical. Most importantly, fast development minimizes the impact of a changing environment. If the development time can be reduced

from eighteen months to nine, the odds of things changing are similarly greatly reduced that makes the need to reduce the time during the development stage. Most firms have reduced product development times over the past five years with the average reduction being about the one-third. In short, the challenge here is to shorten development time so as to minimize the chances that the developmenttarget has changed.

Seeking customer feedback is a vital activity throughout the development stage, both to ensure that the product design is right and also to speed development toward a correctly defined target. The original voice-of-customer research that was done prior to development may not be enough to resolve all the design problems during development (Cooper, 1999). Customer feedback is perhaps the most certain way of seeking continual and honest customer input during the development phase. Seeking customer input should become an integral part of the design team to speedup and make the development stage successful.

Metrics for Development: Development time is defined as the duration from the start to completion of the development stage, i.e., the length of time to develop a new product after passing business case stage to initial market sales. Precise definitions of the start and end point vary from one company to another and may also vary from one project to another within the company. How quickly the team moves through this stage is critical for the reasons stated earlier, and as such, it is imperative that the team measures their progress according to time.

A cross-functional team is defined as a team consisting of representatives from the various functions involved in product development, usually including members from marketing, R&D, and operations (and perhaps others, such as purchasing, asneeded). The most effective development teams also involve suppliers in the early stages of development, and frequently rely on suppliers for a large portion of the subsystem design (Clark & Fujimoto, 1988). Cross-functional teams have replaced a more functional approach in which each team relinquishes project responsibility to a down-stream function (e.g. the engineering team hands-off to the manufacturing team). This paradigm requires frequent communication between functions represented on the team and co-location greatly facilitates this process. Cross- functional teams are essential for timely development, improving design quality, and lowering development costs. Cross-functional integration that really matters occurs when individual design engineers work together with individual marketers or process engineers to solve joint problems in development. True cross-functional integration occurs at the working level. It rests on the foundation of tight linkages in time and in communication between individuals and groups working closely related problems. How these groups work together determines the extent and effectiveness of integration in the design and development of the product (Wheelwright & Clark, 1992).

Related to the above is the degree to which team members are committed, or dedicated, to the project. Since project team members' time commitments are typically spread across a number of projects at any one time because departmental managers are vying for team members' time, team members are often on and off development projects. This creates a discontinuity and

increases development time.It is in this stage that it is crucial to have a team with dedicated team members. A dedicated, accountable team leader- that is, not doing too many other projects or other assignments at the same time, and held accountable for the result. Parallel processing involves activities that are undertaken concurrently (rather than sequentially), thus more activities are undertaken in an elapsed period of time. The purpose is to achieve product designs that reflect customer wants as well as manufacturing capabilities and to do so in the shortest possible time. However, due to the need for prerequisite information, not all activities or phases in the NPD process can be overlapped with minimal risk. Therefore, the degree of parallelism must be measured to ensure minimal downstream risk.

The degree of design effort on real customer needs is a qualitative in-process metric which ensures as much as possible that the final design meets customer requirements. This requires seeking customer input and feedback throughout the entire development stage and thus the customer becomes an integral part of the design team to overcome technical problems that arise and that necessitate product design changes during the development stage. Customer needs and wants assessment must be a vital and ongoing activity throughout development, both to ensure that the product is designed right and also to speed development toward a correctly defined target.

Tools and techniques for Development:

The literature review has shown that there exist a number of tools and techniquesto reduce development times that are consistent with sound management practice.

Dynamic time to market is a tool which can be useful in predicting the end date of the said project as well as in tracking the progress of a project. It works in the following way: when a schedule prediction is made, the prediction date is plotted against the date the prediction was made. By assessing dynamic time to market, the team members will get an early warning of potential late delivery and appropriate action can usually be taken by the team to maintain schedule integrity. Thus projects are kept on schedule to achieve timely product development.

The degree of team cohesiveness gauges the growth of the team as a workinggroup and it is a function of length of time that a team has worked together in a past or present project (Balakrishnan, 1998). It is the extent to which teammembers are attracted to the team and motivated to remain in it.

Overlapping means doing various activities in parallel rather than doing them sequentially. By overlapping activities, the cycle time, i.e. the total time taken to complete the product development from concept until the product reaches market, can be greatly reduced. Overlapping activities saves time due to 1) parallel processing of activities, 2) better and more timely identification of design problems, and 3) improved communication earlier and throughout the team. This metric serves as an indicator of the degree of concurrency in the process. In general, the higher the number of overlapped activities, the higher the degree of concurrency and the shorter is the development time. A lower number of overlapped activities indicates a lower degree of concurrency in the process and may also indicate

opportunities for improving the process to achieve objectives.

Testing: The purpose of this stage is to provide final and total validation of the entire project: the commercial viability of the product, its production, and its marketing (Cooper & Kleinshmidt, 1987). Design and testing go hand in hand, with testing being conducted throughout the development stage. Information obtained during testing is used in developing the product. This phase is extremely important in that it may dramatically decrease the chances of failure in launch, since it has the capacity of revealing flaws that could cause market failure (Urban & Hauser, 1993). Studies by Cooper (1998, 1999) show that a test phase that is customer oriented is the critical factor - whether it is done and how well it is executed - is significantly correlated with the new product success. Different types of testing, i.e. concept testing, prototype/development testing, and test marketing, should be conducted in this stage Cooper (1993, 1998, 2001). It should be noted, however, that testing should not be solely restricted to this stage; it must be conducted throughout the NPD process (Ulrich & Eppinger, 2011).

CSF for Testing: Product functionality is critical for the testing stage as the aim here is to see whether a product with the attributes called for has been produced. It must be proven that claimed attributes exist and the causes for missing attributes must be found.

Customer acceptance is critical for this stage to gauge whether the product is acceptable to the customer, to measure the customer's level of interest, liking, preferences, and intent to purchase, and to determine those benefits, attributes, and features of the product to which the customer responds. Not only must the product work right in the lab or development department, but, more importantly, it must also work right when the customer uses it. The product must excite and, indeed, delight the customer; who must find it not only acceptable but actually like it better than what he or she is currently buying. In short, the customer reaction must be sufficiently positive so as to establish purchase intent.

Metrics for Testing: The performance of a product is how well the product achieves the functionality desired. Product performance is usually measured in such ways as testing physical features, perceptual features, functional modes, and perceived benefits. Feature is those aspects of an offering that create the benefits; they are typically a focal point of NPD. Perceived benefits are the best point in the needs continuum on which to focus conversations with customers because they represent customer-oriented perceptions but are still close enough to supplier-oriented features to permit that linkage to be made by the product developer. Validation and user testing techniques are used to gather data on product performance. These primary research techniques generate quantitative results. At this stage in the NPD process, these are the types of research results necessary to make final critical decisions and reduce the risk of possible failed launches.

Customer-perceived value is measured to determine whether the customer is willing to purchase the tested product or not and to gauge whether the product is acceptable to the customer. Important metrics for this stage are: perceived relative performance, customer

satisfaction (Like/Dislike), and the preference score todetermine the nature of the competitive situation. These are qualitative metrics, but are very important nonetheless to record the basic likes/dislikes of the customer early before the product gets launched into the market. Based on the qualitative data, managers can take action to make changes in the product.

Tools and techniques for Testing: Validation testing is of a product model that closely resembles the final product that will be manufactured and sold, and is often called system testing and usually takes place in-house. The purpose of the testing process is to ensure that all product performance requirements and design specifications have been met. The validation test is normally conducted late in the development process to ensure that all of the product design goals have been met. This includes usability, performance, and robustness. Validation tests normally aim to evaluate actual functionality and performance, as is expected in the production version and so activities should be performed in full. It is probable that the validation test is the first opportunity to evaluate all of the component elements of the product together, although elements may have been tested individually already. Thus, the product should be as near to representing the final item as possible, including packaging, documentation and production processes. Also included within validation tests will be any formal evaluation required for certification, safety or legislative purposes.

Data from a validation test is likely to be quantitative, based on measurement of performance. Normally, this is carried out against some benchmark of expected performance or criteria set before. Usability issues may be scored in terms of speed, accuracy or rate of use, but should always be quantified. Issues such as desirability may be measured in terms of preference or user ranking. Data should also be formally recorded, with any failures to comply with expected performance logged and appropriate corrective action determined.

User and field testing is performed by real users or customers, and in some cases, this testing must precede product shipment. This is not to be confused withmarketing customer testing, where certain strategies regarding sale and marketing of the product are explored. The purpose of testing is to understand how the product performs in the end-user environment. Customer based testing is indeed complex, and there is no way it can be simulated in laboratories, where use is isolated from users' mistakes, competitive trashing of the concept, and objections by those in the user firm or family whose work or life is disrupted by the change. Products that are entirely new to the market should receive beta testing because there is no base of data on which to judge customer acceptance.

Test protocols are produced by the company and can range from rigorous to nonexistent. In the first case, the developer closely monitors and follows up the beta test with in-house staff or contracted staff from a specialty testing company. In the second case the developer may simply contact the customer by phone or have an group or individual contact to ask for opinions on the product. The test results attempt to confirm that the user feels the same toward the prototype as toward the verbal concept discussed earlier in the NPD stage. The results of the testing either confirm that the product meets its requirement or show the areas where theproduct is deficient and is therefore a critical stage to be considered in the

development process.

Framework of CSFs, metrics and tools and techniques for NPD: The CSFs, metrics, tools and techniques proposed for successful NPD discussed in the previous sections are all summarized in the framework proposed in Table 1.

Stage	Critical Success Factor	Metrics	Tools and Technique
New Product Strategy	Clear Strategy	Return on Investment	Financial Analysis
	Well Communicated Strategy	Degree of Communication	Balanced scorecard asa Communication Tool
Idea Generation	Customer Focused Idea Generation	Number of Customer Focused Ideas Generated	Lead User Methodology
			Ethnographic Approach
Screening and Business Case	Up-Front Homework	Expected Commercial Value(ECV)	Financial Method of evaluation
		Net Present Value (NPV)	
		Internal Rate of Return (IRR)	
		Productivity Index (PI)	
Development	Speed	Development time	Team Cohesiveness
	Customer feedback	Degree of functional integration	Dynamic Time toMarket
		Degree of team commitment	Degree of Parallelism
		Concurrency of activities	
		Degree of design effort on real customer priorities	
Testing	Product Functionality	Product Performance	Validation Testing
	Customer Acceptance	Customer-Perceived Value	User and Field Testing

Table 1. Critical Success Factors and Metrics for Stages of NPD Process

For each stage of the NPD process, the factors that are essential for success for each stage, metrics which can be used to measure the performance of those factors, and tools and techniques to implement the metrics are all detailed in the framework. As a preliminary proposed framework, we believe that any complex NPD project that follows this framework will have an increased chance at success.

CONCLUSIONS

New product success still remains the critical challenge for companies. Many companies are aware of the major role new products must play in their future and quest for prosperity: companies are constantly searching for ways to revitalize, restructure and redesign their NPD practices and processes for better results.

This framework proposes that to achieve success, NPD firms should have a clearand well communicated new product strategy. These firms should have well defined new product arenas along with long term trust, with clear goals. Successful businesses and teams of NPD have a dedication towards the voice of the customer. It is critical that firm should gather as many ideas as possible and a large numberof these should come from customers so that the firm can be in a position to design and develop winning new products. Up-front homework prior to the initiation of product design and development is found to be a key factor in a firm's success. The quality of execution of the predevelopment steps - initial screening, preliminary market and technical studies and business analysis - is closely tied to the products financial performance. Firms should try to shorten the development time so as to minimize the chances that the development and customer needs have changed when the product comes into the market. It is important to verify and validate product performance requirements and design specifications along with customer's acceptance before launching the product into the market via validation and userfield testing.

This paper explored and analyzed the NPD process and attempted to identify ways in which firms can improve their performance when developing new products, mainly through the study of factors that are critical to success. These factors were identified through an extensive study of the practices and performance of successful firms presented in the NPD literature. The CSFs which have been described in the literature are generally defined for the overall development process, rather than specifically addressing each stage. To overcome this problem, this paper sought out CSFs for each stage of the process. Presumably, no other study to date has developed such a framework, which can be crucial for NPD success.

Several different research directions could provide additional useful information both to firms finding CSF and measuring product development success as well as to academics performing research in this area. The first research opportunity exists in implementing or testing the proposed framework. This would be useful to do over the longer term both among the community of NPD companies and through academic research to determine the impact of this research on both practice and research.

REFERENCES

[1] Balakrishnan, A. (1998). *Concurrent engineering: Models and metrics*. Master dissertation, McGill University, Canada.
[2] Belliveau, P., Griffin, A., & Somermeyer, S. (2002). Meltzer, R. in *The PDMAtoolbook for new product development*, New York: John Wiley & Sons.
[3] Booz, Allen, & Hamilton. (1982). *New product management for the 1980's*. NewYork: Booz, Allen & Hamilton, Inc.
[4] Clark, K., & Fujimoto, T. (1988). *Product development in the world auto industry: Strategy, organization, and performance*. Boston: Harvard Business School.
[5] Cooper, R. (1980). *Project NewProd: What makes a new product a winner?* Quebec Industrial Innovation Centre.
[6] Cooper, R.G., & Kleinschmidt, E.J. (1987). New products: What separates winners from losers?. *Journal of Product Innovation Management*, 4(3), 169-184.
[7] Cooper, R. (1993). *Winning at new products: accelerating the process from idea to launch* (1st Ed.). Massachusetts: Perseus Publishing.
[8] Cooper, R. (1998). *Product leadership: Creativity and launching superior new products.* Massachusetts: Perseus Books, Reading.

[9] Cooper, R. (1999). From experience: The invisible success factors in product innovation. *Journal of Product Innovation Management*, 16, 115-133.
[10] Cooper, R., Kleinschmidt, E., & Edgett, S. (2000). New problems, new solutions: Making portfolio management more effective. *Research Technology Management*, 43(2), 18-33.
[11] Cooper, R. (2001). Winning at new products: Accelerating the process from idea to launch (3rd Ed.). Massachusetts: Perseus Publishing.
[12] Cooper, R., & Edgett, S. (2008). Maximizing Productivity In Product Innovation. *Research Technology Management*, 51(2), 47-58.
[13] Cooper, R., & Kleinschmidt, E. (1995). Benchmarking the firm's critical success factors in new product development. *Journal of Product Innovation Management*, 12, 374-391.
[14] Cooper, R., & de Brentani, U. (1984). Criteria for screening new industrial products. *Industrial Marketing Management*, 13, 149-156.
[15] Crawford, C. (1979). New product failure rate- facts and fallacies. *ResearchManagement.*

CHAPTER-7.2

A Short Reference to The Indian Scenario for Current Green Marketing

Harish Prasad Sati, Dr. Anuj Gupta
Management Department, JB Institute of Technology, Dehradun
harishprasadsati123@gmail.com

ABSTRACT: *The primary necessity at the moment is to maintain our natural environment's safety as well as the loyalty of our clients and consumers in the modern era of globalisation. The term "environmental pollution" is frequently used in the business world nowadays. The effects of environmental pollution and global warming are other topics that consumers are aware of. Green marketing is a phenomenon that has grown particularly significant in the modern marketplace. It has become a key idea in India as well as other developing and industrialised nations, and it is viewed as a crucial tactic for promoting sustainable development. The concept, necessity, and importance of green marketing have received the most attention in this research work.*

Keywords Green Marketing, Recycle, Sustainable, Eco friendly.

INTRODUCTION

According to the American Marketing Association, green marketing is the marketing of products that are presumed to be environmentally safe. Thus green marketing incorporates a broad range of activities, including product modification, changes to the production process, packaging changes, as well as modifying advertising. Yet defining green marketing is not a simple task where several meanings intersect and contradict each other; an example of this will be the existence of varying social, environmental and retail definitions attached to this term. Other similar terms used are Environmental Marketing and Ecological Marketing. Thus "Green Marketing" refers to holistic marketing concept wherein the production, marketing consumption an disposal of products and services happen in a manner that is less detrimental to the environment with growing awareness

about the implications of global warming, non-biodegradable solid waste, harmful impact of pollutants etc., both marketers and consumers are becoming increasingly sensitive to the need for switch in to green products and services. While the shift to "green" may appear to be expensive in the short term, it will definitely prove to be indispensable and advantageous, cost-wise too, in the long run.

Pride and Ferrell (1993) Green marketing, also alternatively known as environmental marketing and sustainable marketing, refers to an organization's efforts at designing, promoting, pricing and distributing products that will not harm the environment

Polonsky (1994) defines green marketing as .all activities designed to generate and facilitate any exchanges intended to satisfy human needs or wants, such that the satisfaction of these needs and wants occurs, with minimal detrimental impact on the natural environment.

Elkington (1994: 93) defines green consumer as one who avoids products that are likely to endanger the health of the consumer or others; cause significant damage to the environment

during manufacture, use or disposal; consume a disproportionate amount of energy; cause unnecessary waste; use materials derived from threatened species or environments; involve unnecessary use of, or cruelty toanimals; adversely affect other countries.

OBJECTIVES OF THE STUDY

- To discuss the need for Green marketing in India from different perspectives.
- To understand the strategy needed for successful Green marketing.
- To study the present scenario and potential of Green marketing in India
- To study the challenges faced by Green marketers in India.

LITERATURE REVIEW

Green marketing has been an important academic research topic since it came. (Coddinton.1993; Fuller;1999; Ottman,1994). Attention was drawn to the subject in the late 1970‘s when the American Marketing Association organized the first ever workshop on

- Ecological marketing in 1975 which resulted in the first book on the subject entitled.
- Ecological Marketing by Henion and Kinnear in 1976, Peattie and Crane (2005).

claims that despite the early development, it was only in the late 1980‘s that the idea of Green Marketing actually made an appearance because of the consumers growing interest in green products. Green marketing was given prominence in the late 1980s and 1990s after the proceedings of the first workshop on Ecological marketing held in Austin, Texas (US), in 1975. Several books on green marketing began to be published thereafter. The green marketing has evolved over a period of time. According to Peattie (2001), the evolution of green marketing has three phases. First phase was termed as Ecological" green marketing, and during this period all marketing activities were concerned to help environment problems and provide remedies for environmental problems. Second phase was "Environmental" green marketing and the focus shifted on clean technology that involved designing of innovative new products, which take care of pollution and waste issues. Third phase was "Sustainable" green marketing. It came into prominence in the late 1990sand early 2000. During 1990s, the concern for environment increased and resulted in to increasing challenges for the companies (Johri and Sahasakmontri, 1998). Dutta, B. (2009, January) in his article on Green Marketing titled Sustainable Green Marketing The New Imperative published in Marketing Mastermind states that Green Marketing involves developing good quality products which can meet consumer needs and wants by focusing on the quality, performance, pricing and convenience in an environment-friendly way. Barkar is of the viewthat, Companies need to believe first that Green Marketing „can work“ and make diligent effort to make necessary product improvements, which deliver performance, and are marketable and profitable. Unruh, G. And Ettenson, R. (2010) in their research article titled, Growing Green: Three smart paths to developing sustainable products. Published in Harvard Business Review, is for executives

who believe that developing green products make sense for their organization and need to determine the best path forward. The authors have introduced and described three broad strategies that companies can use to align their green goals with their capabilities:

Elkington (1994: 93) defines green consumer as one who avoids products that are likely to endanger the health of the consumer or others; cause significant damage to the environment during manufacture, use or disposal; consume a disproportionate amount of energy; cause unnecessary waste; use materials derived from threatened species or environments; involve unnecessary use of, or cruelty to animals; adversely affect other countries.

- **Accentuate:** Strategy involves playing up existing or latent green attributes in your current portfolio.
- **Acquire:** Strategy involves buying someone else‘s green brand.
- **Architect:** Strategy involves architecting green offerings – building them from scratch.

Green marketing mainly focuses on four issues. These issues are: first, importance of green marketing; second, impact of green marketing on firms‟ competitiveness and performance; third, improving effectiveness of green marketing. In India green Marketing is a relatively new topic introduced by few multinational companies operating in India like Philips India limited.

WHY GREEN MARKETING?

In the present scenario, challenge is to keep the customers as well as consumers in fold and even keep our natural environment safe – which is the biggest need of the time. Companies may loose many loyal and profitable customers and consumers due to absence of green management. In today‘s innovative business world of high technology due to growing community and consumer interests in green and socially responsible products, increased community pressure on companies to internalize externalities, such as health issues, neighborhood amenity, climate change; environmental and governmental legalizations and initiatives; innovative technologies and approaches of dealing with pollution, improved resource and energy efficiency, and to retain old (loyal and profitable) customers and consumers, it is very much urgent to implement green marketing. Further green management produces new environment friendly customers which lead to increase in sales and profits of an organization that leads to growth and development of business; it also leads to good public image of the organization. In the present times when the government regulations around the globe are very strict and the whole world is talking about global warming ,climate change and environment protection the companies would be left with no option but to adopt green marketing otherwise it might be too late to survive in the greener world. The consumer‘s world over in general and India in particular are increasingly buying energy efficient products. In a nutshell most of the companies are venturing into green marketing because of the following reasons:

In India, around 25% of the consumers prefer environmental-friendly products, and around

28% may be considered healthy conscious. Therefore, green marketers havediverse and fairly sizeable segments to cater to.

- Many companies have started realizing that they must behave in an environment-friendly fashion and believe both in achieving environmental objectives as well as profit related objectives.
- Various regulations recently framed by the government to protect consumers and the society at large led to the adoption of Green marketing as a compulsion rather than a choice. For example, the ban of plastic bags in many parts of the country, and prohibition of smoking in public areas, etc.
- Many companies take up green marketing to maintain their competitive edge.

GREEN MARKETING FOR SUCCESS IN MARKET

To be successful green marketing companies there are a few fundamental rules that will go a long way in shaping the future of the business in the coming years. The fundamental strategy isto use the Four P's suitably modified to meet the needs of Green Marketing, but there are a few points that need to be stressed before embarking on Strategy. They are:

Knowing Customer: Means making sure that the consumer is aware of and concerned about the issues that your product attempts to address, without which success in green marketing will be difficult to achieve.

Educating customer: Means educating the people about the reasons as to whatever you're doing is not only to protect the environment, but also matters of letting them know why it matters. Otherwise, for a significant portion of your target market, it's a case of "So what?", –Does it matter to me? and your green marketing campaign goes nowhere.

Genuineness & Transparency to the customer: It shows that a) In reality you are actually practicing, what you claim to be doing in your green marketing campaign and b) your business policies are in lieu with whatever you are doing that's ecofriendly. Both these conditions have to be met for your business to establish the kind of environmental credentials that will allow a greenmarketing campaign to succeed.

1. Reassuring the Buyer: Means that the customers must be made to believe that the product being offered shall fulfill the objective or purpose for which it has been purchase i.e.-no compromise in product quality in the name of the environment.
2. Pricing for the customer: Means making sure that consumers can afford the premium and feel it's worth it, which is being charged for your product, as many environmentally preferable products cost more due to economies of scale and use of higher-quality ingredients.
3. Giving the customers an opportunity to participate: Means personalizing the benefits of your environmentally friendly actions, normally through letting the customer take part in positiveenvironmental action, at same time keep in view the changed expectations of the

customers.

The Four Ps of Green Marketing: Like conventional marketers, green marketers must address the Four Ps ‘in new perspective in view of changed scenario.

Product: Marketers wanting to exploit emerging green market either identify customers environmental needs and develop products to address these needs; or develop environmentally responsible products to have less impact than competitors. The increasingly wide variety of products on the market that support sustainable development and are good for the triple bottom line include:

- Products made from recycled goods.
- Products that can be recycled or reused.
- Efficient products, which save water, energy or gasoline, save money and reduce Environmental impact. Products with environmentally responsible packaging. Products with green labels, as long as they offer substantiation.
- Organic products — many consumers are prepared to pay a premium for organic products, which offer promise of quality. A service that rents or loans products – such as toy libraries. Certified products, which meet or exceed environmentally responsible criteria.

Price

- Pricing is a critical element of the marketing mix. Most customers are prepared to pay a premium if there is a perception of additional product value.
- This value may be improved performance, function, design, visual appeal or taste. Environmental benefits are usually an added bonus but will often be the deciding factor between products of equal value and quality.
- Environmentally responsible products, however, are often less expensive when product life cycle costs are taken into consideration.

Place

- The choice of where and when to make a product available has a significant impact onthe customers being attracted.
- Very few customers go out of their way to buy green products merely for the sake of it. Marketers looking to successfully introduce new green products should, in most cases, position them broadly in the market place so they are not just appealing to a small green niche market.
- The location must also be consistent with the image which a company wants to project. The location must differentiate a company from its competitors. This can be achieved by in-store promotions and visually appealing displays or using recycled materials to emphasize the environmental and other benefits.

Promotion

- Promoting products and services to target markets includes paid advertising, public relations, sales promotions, direct marketing and on-site promotions.
- Smart green marketers will be able to reinforce environmental credibility by using sustainable marketing and communications tools and practices. For example, many companies in the financial industry are providing electronic statements by email, e-marketing is rapidly replacing more traditional marketing methods, and printed materials can be produced using recycled materials and efficient processes, such as waterless printing.
- Retailers, for example, are recognizing the value of alliances with other companies, environmental groups and research organizations when promoting their environmental commitment. To reduce the use of plastic bags and promote their green commitment, some retailers sell shopping bags, under the banner of the Go Green Environment Fund.
- The key to successful green marketing is credibility. Never overstate environmental claims or establish unrealistic expectations and communicate simply and through sources that people trust.
- Promote your green credentials and achievements. Publicize stories of the company's and employees green initiatives. Enter environmental awards programs to profile.
- Environmental credentials to customers and stakeholders.

PRESENT TRENDS IN GREEN MARKETING IN INDIA

Organizations are Perceive Environmental marketing as an Opportunity to achieve its objectives. Firms have realized that consumers prefer products that do not harm the natural environment as also the human health. Firms marketing such green products are preferred over the others not doing so and thus develop a competitive advantage, simultaneously meeting their business objectives.

Organizations believe they have a moral obligation to be more socially responsible. This is in keeping with the philosophy of CSR which has been successfully adopted by many business houses to improve their corporate image. Firms in this situation can take two approaches:

- Use the fact that they are environmentally responsible as a marketing tool.
- Become responsible without prompting this fact.

Governmental Bodies are forcing Firms to Become More Responsible. In most cases the government forces the firm to adopt policy which protects the interests of the consumers. It does so in following ways:

- Reduce production of harmful goods or by products
- Modify consumer and industry's use and /or consumption of harmful goods; or

- Ensure that all types of consumers have the ability to evaluate the environmental composition of goods.

Competitors' Environmental Activities Pressure Firms to change their Environmental Marketing Activities. In order to get even with competitors claim to being environmentally friendly, firms change over to green marketing. Result is green marketing percolates entire industry.

Cost Factors Associated With Waste Disposal or Reductions in Material Usage Forces Firms to Modify their Behavior. With cost cutting becoming part of the strategy of the firms it adopts green marketing in relation to these activities. It may pursue these as follows:

- A Firm develops a technology for reducing waste and sells it to other firms.
- Encourage consumer evangelism via consumers social and internet communication network with compelling, interesting and entertaining information about environmental products.

GREEN MARKETING- CHALLENGES

Although a large number of firms are practicing green marketing, it is not an easy job as there are a number of problems which need to be addressed while Implementing Green marketing.

The major challenges to Green marketing which have to be faced are:

- **New Concept:** Indian literate and urban consumer is getting more aware about the merits of Green products. But it is still a new concept for the masses. The consumer needs to be educated and made aware of the environmental threats. The new green movements need to reach the masses and that will take a lot of time and effort.
- **Cost Factor:** Green marketing involves marketing of green products/services, green technology, green power/energy for which a lot of money has to be spent on R&D programmes for their development and subsequent promotional programs which ultimately may lead to increased costs.
- **Convincing customers:** The customers may not believe in the firm’s strategy of Green marketing, the firm therefore should ensure that they undertake all possible measures to convince the customer about their green product, the best possible option is by implementing Eco-labeling schemes. Eco-labeling schemes offer its ‒approval‖ to -environmentally less harmless‖ products. In fact the first eco-label program was initiated by Germany in 1978. Sometimes the customers may also not be willing to pay the extra price for the products.
- **Sustainability:** Initially the profits are very low since renewable and recyclable products and green technologies are more expensive. Green marketing will be successful only in long run.

Hence the business needs to plan for long term rather than short term strategy and prepare for

the same, at the same time it should avoid falling into lure of unethical practices to make profits in short term. Non-Cooperation- The firms practicing Green marketing have to strive hard in convincing the stakeholders and many a times it may fail to convince them about the long term benefits of Green marketing as compared to short term expenses. Avoiding Green Myopia- Green marketing must satisfy two objectives: improved environmental quality and customer satisfaction. Misjudging either or overemphasizing the former at the expense of the latter can be termed –green marketing myopia. In short firms using green marketing must ensure that their activities are not misleading to the consumers or the industry, and do not breach any of the regulations or laws dealing with environmental marketing. The green marketing claims of a firm must do the following in order to overcome the challenges:

- Clearly state environmental benefits.
- Explain environmental characteristics.
- Explain how benefits are achieved.
- Ensure comparative differences are justified.
- Ensure negative factors are taken into consideration.
- Only use meaningful terms and pictures.

CONCLUSION

Green marketing will not be an easy concept. The company needs to plan and then research to find out how feasible this is. Green marketing needs to evolve as it is still in its infancy. It may not be easy to do eco-friendly marketing in the short term, but it will definitely make a positive difference to your business in the long run. Green marketing is still in its infancy in Indian companies. The Indian market offers many opportunities. Customers are also willing to pay a higher price for environmentally friendly products. This shift in consumer behavior is forcing companies to consider the negative impact of their activities on the global natural environment. The rapid increase in environmental concerns over the past two decades is forcing companies to make changes to ensure society's sustainability. Green marketing should not be seen as just another marketing approach but should be pursued more vigorously as it has social and environmental dimensions. Retailers also have a duty to raise awareness among stakeholders about the need and benefits of organic products. Companies are now realizing that they cannot survive in today's competitive age without considering the environment as a central part of their strategy. Indian FMCG companies also rely on "Green" to protect their image in the market. Companies engage in various activities to express their concern for the environment and society. At the same time, however, companies must understand that green marketing must not neglect the economic aspect of marketing. Green marketing helps achieve effective results cost reduction, employee satisfaction, waste minimization, common good for economy and society. All that is required is the determination and commitment of all of the company's stakeholders. Marketers also have a responsibility to educate consumers about the need for, and benefits of, organic versus non-

organic products, and what benefits they may derive from them in the future. Eco-friendly retailers can count on the government's full support and consumers will not hesitate to pay more for a cleaner and more environmentally friendly environment. Finally, consumers, industrial buyers and suppliers need to promote the positive environmental impact of green marketing. Green marketing is gaining more and more importance in developing countries of the world like India, which is supposed to be seen as a pioneer and trendsetter for everyone else.

REFERENCES

[1] Unruh, G. And Ettenson, R. (2010, June). Growing Green; Three smart paths to developing sustainable products.Harvard Business Review. Vol. 5(6). Boston.
[2] Ottman, Jacquelyn. 1993. Green Marketing: Challenges and Opportunities for the New Marketing Age. Lincolnwood, Illinois: NTC Business Books.
[3] Kotler, Philip. Marketing Management – The Millennium Edition Prentice Hall of India Private Limited, NewDelhi.
[4] *Green Marketing"* (2010, March 29). Journal: Business Practices.
[5] J.A Ottman,. et al, "Avoiding Green Marketing Myopia", Environment, Vol-48, June-2006
[6] Mathur, L.K., Mathur, I. (2000).An Analysis of the wealth effect of green marketing strategies, Journal of Business Research, 50(2), 193-200.
[7] J. M. Ginsberg and P. N. Bloom, ―Choosing the Right Green Marketing Strategy,‖ MIT Sloan Management Journal, fall 2004: 79–84.
[8] Sustainable Green Marketing the New Imperative. Dutta, B. (2009, January). Marketing Mastermind. Hyderabad: The ICFA University Press.
[9] .J. Makower, ―Green Marketing: Lessons from the Leaders,‖ Two Steps Forward, September 2005.
[10] www.greenmarketing.net/stratergic.html
[11] www.cohnwolfe.com/en/ideas-insight/white-papers/green-brands-survey-2011
[12] www.greenmarketing.net/stratergic.html
[13] http://en.wikipedia.org/wiki/Green_marketing
[14] www.emeraldinsight.com/024503.ml
[15] Businesswireindia.com

CHAPTER-7.3

Organizational Commitment and Compensation- A Review with Respect to Telecommunications

Nimisha Verma, Dr. Anuj Gupta
Management Department, JB Institute of Technology, Dehradun
harishprasadsati123@gmail.com

ABSTRACT: *The theoretical literature on the topic of organizational commitment and compensation in telecommunication sector has been briefly reviewed in this research article. Any organization's development depends significantly on its human resources and organizational commitment. According to the information derived from the previous papers in the context of Human Resource Management (HRM). Specifically, this paper examines theoretical insights to explain organizational commitment in the Indian telecommunications sector. According to the research, organizations are required to be attentive towards the culture prevailing in the organization. This paper has examined various dimensions of organization's commitment which is influenced by pay in Indian telecom sector. A road map for future researchers has also been provided in this study.*

INTRODUCTION

A company's commitment to its workforce is more important today than it was in the past. In order to increase market share and retain customers, organizations focus on continuous improvement to sustain competitive advantage. It is necessary to have a better workforce in order to retain better customers. Employee retention can also be predicted using the concept of organizational commitment. Maintaining competitive advantage in terms of manpower has also become a top priority for managers in many organizations. Employers desire employee contributions to help them to focus new markets and set their goods and services apart from those of their rivals. However, employees frequently experience job uncertainty and a lack of confidence, which makes them less devoted to the company. Employees are more likely to be kept by organizations if they receive competitive pay and stronger incentive programmes.

CONCEPT OF ORGANIZATIONAL COMMITMENT

The strength of an employee for performing the task in an organization and to the extent an employee gets involved with the organization is termed as Organizational Commitment (OC). OC relates to how much an employee engages him or her in order to accomplish the goals need to be achieved by the organization. Additionally, it refers to the identification of quality employees as human capital in an organization. The categorization through the previous literature as in affective, continuance and normative commitment plays a crucial role in order to maintain the loyal workforce within the organization. An intention to stay with the company is referred to as a continuance commitment. In some cases, honors and recognition encourage employees to stay with the company because quitting could be detrimental. The third commitment is normative, which expresses a duty or sense of loyalty among employees to continue being a part of a company, John (2011) stated in his study that trustworthiness, image and relationship are the main factors which influence the loyalty of the employees at

workplace. From the factor analysis, it was found that trustworthiness was the key factor that motivated the employees to remain loyal to their organization. According to Loan et al., (2020) job performance and organizational commitment have positive relationship. OC enhances the attitude of employees at workplace (Ahad et al., 2021). The turnover intention is likely to get reduced due to organizational commitment (Pratama et al., 2022). High OC creates high- involvement among employees (Schwarz, 2023).

CONCEPT OF COMPENSATION

Organizations provide compensation to their employees as a reward for performing different tasks within the organization. The compensation is linked to the measures of performance. Providing employees with necessary information should be a part of a firm's compensation design so as to encourage them to stay for a long time (Clinch, 1991). A number of variables are chosen from the literature already available. The following are the determinants of it.

Basic Pay: It is a crucial resource for meeting the needs of the workforce. As a result, it is one of the hygiene elements influencing employee conduct at work (Boaden, 1997). Employee commitment is what drives organizational performance, and employee commitment comes when they are compensated adequately. One of the key elements in motivating employees and keeping them with the company is pay packages (Ngirande, 2014).

Flexible pay: Bonuses are included in flexible pay, and because employees have the option to work in a flexible manner, they have a feeling of belonging at work. Due to the organizations' fluctuating revenues, which may affect long-term commitment and remuneration, bonuses are more likely to be variable than fixed pay (Nakamura, 1998). According to Ahmad (2017), a reward system through a bonus offered to the manpower besides to a set salary.

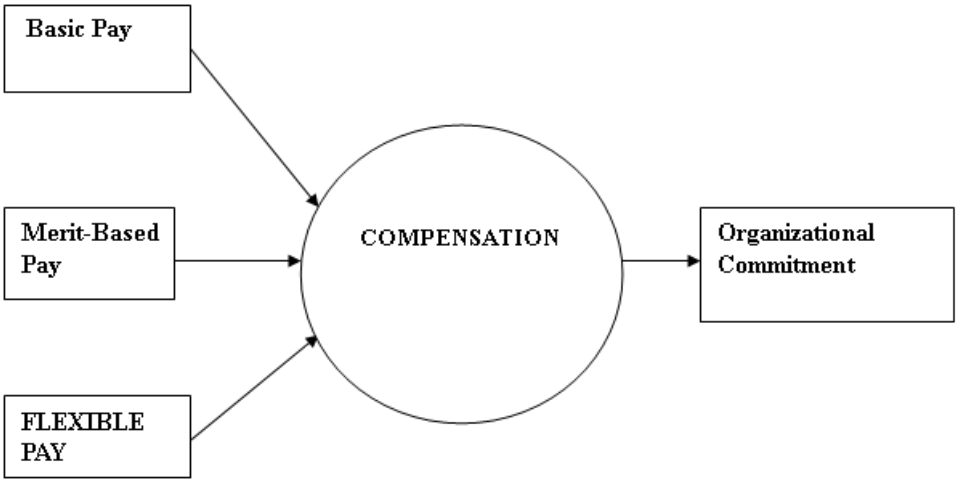
Merit-Based Pay: Merit-based compensation is a system that allows employees to get paid more based on their performance. Performance evaluation, communication, and involvement are its three essential components (Ahmad, 2017). A system of compensation based upon the merit encourages the personnel to concentrate for the accomplishment of task and improve the performance.

FRAMEWORK

Through the several elements of compensation, including basic pay, merit-based pay, and flexible pay, the framework focuses on organizational commitment.

Rationale of the study: To emphasize the significance of a devoted workforce for organizational progress, several writers have performed studies on organizational commitment in a variety of sectors. However, distinct ideas from numerous studies have been included into the literature on organizational commitment. The researcher's goal in conducting this study is to make a sincere contribution in this area. Organizational commitment is made possible the payment of compensation including fixed salaries, flexible salaries, and merit-based salaries which is necessary for having a skilled staff. The variables

selected for this paper after reviewing prior literature provide insight into various compensating factors in relation to organizational commitment.



PROPOSITIONS

Proposition1: Basic wage and organizational commitment are positively correlated.

According to (F.X.Mathaisel, 2003), workers were content with their pay. In this essay, it is suggested that basic wage and organizational commitment are related. Long-term retention is more likely to occur when workers are satisfied with their salaries.

Proposition 2: There has been a positive relation between merit-based pay and organizational Commitment.

It has to do with incentive programmes. It has an impact on the responsibility accounting framework's design structure. According to J. Indjejikian (1999), incentives promote cooperative behaviour and teamwork. Cooperation improves the working atmosphere, which encourages employees to stick with the company. Consequently, it fosters a sense of loyalty among employees towards the company.

Proposition 3: Perks and incentives that a business gives to an employee are linked to flexible compensation, as are organisational commitment and flexible pay. As a result, an employee may feel content, which motivates them to stay with the business. According to (Nakamura, 1991), bonuses are unique to a worker. When both employers and employees share in corporate profits, it is referred to as a profit-sharing system.

CONCLUSION

This paper focuses to provide conceptual model of organizational commitment in accordance with compensation in Indian Context. The factors effecting compensation includes merit-based system, basic-pay and flexible pay have been chosen from the previous literature. Researcher has tried to figure out the positive relation between compensation and organizational commitment. It is suggested that if employees are compensated well, they will remain with the organization for longer run. This might be useful for the organizations to have committed workforce in order to retain employees in their organization.

References

[1] Ahad, R., Mustafa, M. Z., Mohamad, S., Abdullah, N. H. S., & Nordin, M. N. (2021). Work attitude, organizational commitment, and emotional intelligence of Malaysian vocational college teachers. Journal of Technical Education and Training, 13(1), 15-21.

[2] Ahmad, L. F. (2017). Financial Compensation and Organizational Commitment. Compensation and Benefits Review, 1-16.

[3] Boaden, M. S. (1997). One More Time: How Do You Win Orders? A Critical Appraisal of The Hill Manufacturing Strategy Framework. International Journal of Operations and Production.

[4] Clinch, G. (1991). Employee Compensation and Firms' Research and Development Activity. Journal of Accounting Research, 29 No.1, 59-78.

[5] F.X.Mathaisel, C. L. (2003). A Case Study of the Implications of Faculty Workload and Compensation for Improving Academic Quality. International Journal of Educational Management, 17 (5), 200-210.

[6] J.Indjejikian, R. (1999). Performance Evaluation and Compensation Research: An Agency Perspective. Accounting Horizons, 13 (2), 147-157.

[7] John P. Meyer, N. J. (1991). A Three- Component Conceptualization of Organizational Commitment. Human Resource Management Review, 1 (1), 61-89.

[8] John, J. (January 2011). An Analysis on Customer Loyalty In Telecom Sector: Special Sector Reference To Bharat Sanchar Nigam Limited, India. African Journal of Marketing Management, 3 (1), 1-5.

[9] Loan, L. J. M. S. L. (2020). The influence of organizational commitment on employees' job performance: The mediating role of job satisfaction. Management Science Letters, 10(14), 3307-3312.

[10] Masao Nakamura, O. H. (1998). The Bonus Share of Flexible Pay in Germany, Japan and the U.S.: Some Empirical Regularities Japan and the World Economy, 10 (2), 221-232.

[11] Nakamura, M. N. (1991). Risk Behaviour and The Determinants of Bonus Versus Regular Pay in Japan. Journal of The Japanese and International Economies, 5 (2), 140-159.

[12] Ngirande, T.S. (2014). The Impact of Rewards on Job Satisfaction and Employee Retention. Mediterranean Journal of Social Sciences, 5 (1).

[13] Pratama, E. N., Suwarni, E., & Handayani, M. A. (2022). The Effect of Job Satisfaction and Organizational Commitment on Turnover Intention with Person Organization Fit as Moderator Variable. Aptisi Transactions on Management (ATM), 6(1), 74-82.

[14] Schwarz, G., Newman, A., Yu, J., & Michaels, V. (2023). Psychological entitlement and organizational citizenship behaviors: The roles of employee involvement climate and affective organizational commitment. The International Journal of Human Resource Management, 34(1), 197-222.